ENTERPRISE SYSTEMS AND ORGANISATIONAL AGILITY: DEVELOPING AND EXPLORING A CAUSAL MODEL

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ABSTRACT

The highly competitive and turbulent business environment is forcing organisations not only to flexibly adapt to changes when they occur, but also to proactively predict the changes before they impact business operations. Organisational agility (OA) refers to an organisation's ability to compete and thrive in an unstable business environment by quickly detecting and seizing opportunities and tackling threats. OA is increasingly recognised as both critical to business success and growing in importance. A number of previous researchers have investigated the factors, processes, strategies, and structures that contribute to OA. Of these areas, the role of information systems (IS) in general and enterprise systems (ES) such as enterprise resource planning (ERP), customer relationship management (CRM) and supply chain management (SCM) in particular are of interest to this thesis.

Contemporary organisations depend on their ES, cannot survive or grow without ES support, and are investing to build their ES infrastructure to improve performance. Despite the pervasiveness of ES, their impact on OA is an under-researched area. Given that most organisations are investing heavily in ES and the increasing demand for agility, the lack of research on ES and OA is a critical oversight. This research set out to address the question of how ES enables OA. The objectives of the study were (1) to investigate the role of ES in OA and (2) to explore the underlying mechanisms of how ES influences OA.

Previous literature on IS in general and ES in particular and OA are reviewed. The thesis offers a comprehensive and deepened perspective on the existing discourses on ES-enabled OA. Using insights from dynamic capability theory, a conceptual framework is proposed. The framework highlights how organisations can exploit ES to improve their agility in two significant ways—by creating and constantly developing an ES-enabled sensing and responding capability. The quality of the ES competence provides the necessary technical and business platform for deploying and exploiting ES in building and rebuilding sensing and responding capabilities.

This research was led by a positivist paradigm and followed a quantitative approach, using surveys. The development of the research model followed a rigorous research design which included theoretical and operational definitions of the constructs, identification of appropriate methods of data collection and refining the measurements by pretesting using a panel of experts and a pilot study. The proposed model was tested in a large-scale field survey. Data were collected from 179 medium and large organisations in Australia and New Zealand that have implemented and been using ES (i.e., ERP, CRM and SCM) for at least a year. The data were analysed in a two-stage structural modelling procedure using SPSS and PLS.

The theoretical and empirical results show that organisations can achieve agility out of their ES investment in three ways: (1) by developing an ES for technical, human, managerial, vendor, and functional competences; (2) by exploiting their ES competences to build ES-enabled capabilities that digitise their key sensing and responding processes; and (3) when ES-enabled sensing and responding capabilities are aligned than when they are not and when organisations operate in a relatively turbulent environments. The results shed light on three important missing factors in the realm of IT-enabled OA, namely ES competency, the alignment between ES-enabled sensing and responding capabilities, and environmental dynamism (ED).

This research makes an original contribution to theory and practice through its development and validation of a theoretical model for assessing the OA effect of ES. Specifically, the research fills a gap in the available research by uncovering the mechanism by which ES impacts OA by explicitly theorising regarding ES-induced competencies that may be exploited to develop distinctive ES-enabled sensing and responding capabilities to enable OA. The research also provides a number of implications for practitioners on how they can successfully manage their ES by advancing their level of OA.

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of this thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Signed: ___________________________________On: ______/________/_________

Publications

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LIST OF ABBREVIATIONS

AVE	Average Variance Extracted
BPMS	Business Process Management Suites
CBSEM	Covariance Based Structural Equation Modelling
CEO	Chief Executive Officer
CFA	Confirmatory Factor Analysis
CIO	Chief Information Officer
CRM	Customer Relationship Management
DCT	Dynamic Capability Theory
ED	Environmental Dynamism
EFA	Exploratory Factor Analysis
EM	Expectation Management
ERP	Enterprise Resource Planning
ES	Enterprise Systems
ESC	Enterprise System Competence
ESF	Enterprise System Functional Competence
ESH	Enterprise System Human Competence
ESHM	Enterprise System Human and Managerial Competence
ESM	Enterprise System Management Competence
ESR	Enterprise System Enabled Responding
ESS	Enterprise System Enabled Sensing
EST	Enterprise System Technical Competence
ESV	Enterprise System Vendor Competence
ICS	Inventory Control System

IS	Information Systems
IT	Information Technology
KBV	Knowledge Based View
KMO	Kaiser-Myer-Olkin
MAR	Missing At Random
MCAR	Missing Completely At Random
MIS	Management Infomration Systems
MRP	Material Requirement Planning
MRPII	Material Requirement Planning II
MTMM	Multi-Trait Multi-Method Matrix
OA	Organisational Agility
PBV	Process Based View
PLS	Partial Least Squares
SCM	Supply Chain Management
SEM	Structural Equation Modelling
SFL	Standard Factor Loading
SOA	Service Oriented Architecture
USA	United States of America
RBV	Resource Based View
RFID	Radio Frequency Identification
WS	Web Services

CHAPTER 1: INTRODUCTION

This PhD study is about investigating the organisational agility (OA) effect of enterprise systems (ES). Drawing from dynamic capability theory (DCT), the research develops and validates a model and measurement instruments for assessing the impact of ES on OA and explaining the mechanism by which this impact occurs.

Section 1.1 of this chapter provides an overview of the research context. In particular, the chapter provides the definition of OA and explains its importance in the current business context. The rationale for researching the role of information systems (IS) in general and ES in particular for advancing OA is discussed in Section 1.2. Building on the research rationale, the research questions and objectives are presented in Section 1.3. Section 1.4 outlines the research approaches and assumptions. Brief findings of the thesis are presented in Section 1.5. A summary of the contributions of this thesis to theory and practice is presented in Section 1.6. Finally, Section 1.7 provides an overview of the remaining chapters of this thesis.

1.1 BACKGROUND TO ORGANISATIONAL AGILITY AND INFORMATION SYSTEMS

The current highly competitive and turbulent business environment is forcing organisations to not only flexibly adapt to changes when they occur, but also to proactively predict such changes before they impact business operations. Changes that drive an organisation to be agile come from every aspect of the external environment, including politics, economics, society and technology, as well as the internal environment, such as internal strategy and organisation structure (Oosterhout et al. 2006; Sharifi & Zhang 1999). Changes in customer preferences, and rapid technological advances or strategic moves by aggressive competitors result in sustained competitive advantage difficult being difficult to achieve (D'Aveni 1994). OA refers to an organisation's ability to compete and thrive in an unstable business environment by quickly detecting and seizing opportunities and tackling threats (Sambamurthy et al. 2003). Therefore, OA is regarded as a key business factor and an enabler of competitiveness (Ganguly et al. 2009; Mathiassen & Pries-Heje 2006). A McKinsey and Company survey found that nine out of 10 executives ranked OA as both critical to business success and growing in importance over time (Sull 2009). A 2009 survey by the Economist Intelligence Unit indicated that 88 per cent of 249 executives around the world claimed that agility is either extremely important or somewhat important. OA is also an important topic that has been researched from the economic (Ganguly et al. 2009), strategic management (Soule 2002; Weill et al. 2002), and IS perspectives (Izza et al. 2008; Sambamurthy et al. 2003).

A number of previous researchers have investigated the factors, processes, strategies and structures that contribute to OA. For example, Sharifi and Zhang (1999) identify agility drivers, providers, strategies, and capabilities. Hermansen and Caron (2003) report on factors that impact a pro-agility organisational culture. Breu et al. (2002) investigate workforce agility elements. Of all these areas, the role of IS and information technology (IT) in OA is of particular interest to this thesis study. This is because contemporary organisations depend on their IS, cannot survive or grow without IS support, and are investing to build their IT infrastructure to improve performance (Mathiassen & Pries-Heje 2006; Peppard & Ward 2004).

The contribution of IS to OA reported in the literature vary between being an inhibitor or a facilitator (Newell et al. 2007; Oosterhout et al. 2006; Overby et al. 2006). This difference results from two distinctive views of IS infrastructure: (a) a technically-oriented view that constrains IT infrastructure within the scope of a technical artefact (Desouza 2006); and (b) a digital platform view that expands IS infrastructure as a leveraging information platform (Sambamurthy et al. 2003). These two views have led to contradicting conclusions regarding the role of IS in advancing OA. While the IS as a technical artefact view argues that IS, unless inherently agile, inhibits OA (Desouza 2006), the digital platform view supports the view that IS are socio-technical systems and can be leveraged to support OA (Sambamurthy et al. 2003).

1.2 RESEARCH RATIONALE

Although there are a number of studies on the relationship between IS and OA, four research gaps identified in the literature have motivated the research reported in this thesis.

First, the concept and practice of IS-enabled OA is not clearly defined. Although the concept of IS-enabled OA is recognised in a few previous studies, what this concept actually means and what are its constituent parts lacks definitional clarity. Researchers have used the concept to imply IT deployment agility (Tan et al. 2010), IT capability (Overby et al. 2006), and IS-enabled digital options (Sambamurthy et al. 2003). The IS literature is also less clear in its treatment of the concept of OA vis-à-vis the two fundamental attributes of agility, that is, sensing and responding. For example, Overby et al. (2006) view sensing and responding as two components of agility. They argue that by breaking the complex concept of agility into its constituent parts of sensing and responding, agility can be observed and measured separately. This means the concepts of sensing and responding are not different from agility. On the other hand, Seo and Paz (2008) treat sensing and responding as two sequential processes to achieve agility. The output of sensing would become the input of responding. Thus, sensing and responding, although strongly related to, and able to influence agility, are different from agility. Sambamurthy et al. (2003) view IS as the platform that can be leveraged to digitise processes and knowledge to create digital options. Under the moderating effect of entrepreneurial alertness, which consists of strategic foresight and systemic insight, digital options in turn enable OA.

The above three views imply that the structural or ontological standing of how IS contribute to OA and the claims or statements that can be made about the relationship between the two requires clear definition of these constructs and further theorisation. To address these concerns, in this study, OA is defined as one of the organisational performance indicators and is differentiated from the IS-enabled sensing and responding capabilities and the IS competencies that are necessary to build sensing and responding capabilities. Such a structure facilitates the development of testable statements of relationships between IS and OA and allows for knowledge to be accumulated in a systematic manner.

Second, the IS artefact is generically defined. Prior IS studies on OA use IS-related constructs such as IS competence (Sambamurthy et al. 2003), IT usage and IT acceptance (Zain et al. 2005), and the quality of the IT infrastructure (Tallon 2008) that are too broad and abstract. As such, the IS artefact that the studies refer to is generically defined. Orlikowski and Iacono (2001) stress the importance of specifically defining the IS artefact under investigation to advance the relevance and value of IS research. They caution researchers not to take the IT artefact for granted and advise them to ‘explicitly theorise about specific technologies with … distinctive computational capabilities … used for certain activities’ (Orlikowski & Iacono 2001, p. 131). Although some interpret ‘enterprise systems' as being the same as 'information systems' and others (Devadoss & Pan 2007) identify a number of distinguishing characteristics of ES, Alter (2008, p. 458) conjectures that 'various types of information systems differ so greatly in form and function that IS in general has few concepts or generalisations in common.' He suggests that in order to understand the true role of IS, researchers need to specifically and clearly define the IS that they allude to. Given the tradition of ES-specific research, and following Orlikowski and Iacono's (2001) and Alter's (2008) suggestions, this research focuses on ES only. The intention, however, is not to draw distinctions between IS and ES, but to deeply engage with the unique attributes of ES that are not necessarily shared by legacy IS (Devadoss & Pan 2007) in theorising how organisations can exploit ES to enable their sensing and responding capabilities and advance agility.

Third, most ES research focuses on the implementation issues of ES and not how it either inhibits or limits OA. ES refers to integrated IS that use both technology and the management capabilities of that technology to manage information flow in an organisation (Davenport 1998). ES such as enterprise resource planning (ERP), customer relationship management (CRM) and supply chain management (SCM) are the most widely used types of IS and have received a lot of research attention that specifically identifies the challenges, implementation issues, and benefits of such systems (Lim et al. 2005; Moon 2007). Nevertheless, except for anecdotal treatment (e.g., Sambamurthy et al. 2003), how ES either facilitates or inhibits agility remains under-researched. In view of the volume of ES-specific studies and given the trend that most large organisations are moving towards ES and are investing heavily in ES architecture, infrastructure, software and human resources, and the increasing demand for an agile organisation, a lack of research on ES and OA is a significant oversight that needs to be addressed. Nevertheless, despite the pervasiveness of ES and the importance of OA, the relationship between ES and OA remains under-researched. A review of the academic literature reveals only a handful of published papers on ES and OA (Davis 2005; Gattiker et al. 2005; Goodhue et al. 2009; Ignatiadis & Nandhakumar 2007; MacKinnon et al. 2008; Seethamraju & Seethamraju 2009).

Although ES are sometimes viewed as constraining and inflexible, 'like cement, highly flexible in the beginning, but rigid later' (Davenport 2000, p. 16), ES such as ERP, CRM and SCM harness the power of contemporary IT and are used pervasively in most large organisations (Devadoss & Pan 2007; MacKinnon, Grant & Cray 2008). For example, the five-year compound annual growth rate for Enterprise BI, CRM, ERP, and SCM Solution Services is expected to be 4.7 per cent through 2013 (Gartner 2009), while the overall ERP application revenue alone was predicted to reach approximately $45.5 billion by 2011 (Hamerman, Martens & Moore 2011). ES inherit certain IS characteristics but have unique features such as scope, business logic, complexity, standardisation, integration, being process-oriented and continued vendor dependence (Devadoss & Pan 2007; Goodhue et al. 2009; Lengnick-Hall et al. 2004), which results in a distinct contribution toward an organisations' performance. This study specifically focuses on ES.

Fourth, the alignment between sensing and responding and its influence on OA is unexplored. The sensing and responding processes are inter-related and should be aligned. If organisations are unable to sense effectively, opportunities and threats remain unobserved and disregarded. This will limit the organisations' ability to take appropriate action to respond to the opportunities and threats. Alignment between sensing and responding capabilities enables organisations to effectively capture business opportunities by optimising organisational resources (Overby et al. 2006). Moreover, the pressure of change on organisations varies and organisations have different levels of agility needs (Oosterhout et al. 2006; Sharifi & Zhang 1999). Organisations that operate in a dynamic environment require greater agility more urgently than organisations that operate in a less turbulent business environment (Moitra & Ganesh 2005). The level of environmental dynamism (ED) is dependent on both the sophistication of internal conditions and the turbulence of the external business environment (Oosterhout et al. 2006). However, existing discourses on IS and OA have overlooked the concepts of the alignment between ES-enabled sensing and responding capabilities and ED from the nomological net of factors that explain OA.

Furthermore, while few studies have attempted to develop a conceptual framework to explain the impact of ES or IS on OA (Overby et al. 2006; Sambamurthy et al. 2003), the lack of empirical evidence limits the contribution of their research findings to theory and practice. The above four areas drive this research, which is particularly concerned with ES and their relationship to OA. In the next section, the aims and objectives of this research study are discussed.

1.3 RESEARCH QUESTIONS AND OBJECTIVES

The aforementioned gaps provide the justification for conducting this research study which aims to investigate the impact of ES on OA in different environmental contexts by answering following research question:

- *Do enterprise systems enable organisational agility?*

  To address this main question, three subquestions will be investigated, which are:

- *What are the capabilities that can be developed from enterprise systems to advance organisational agility?*
- *What are the enterprise system competences that contribute to the development of these capabilities?*
- *Does the dynamism of a business environment moderate the process of transforming enterprise system capabilities into organisational agility?*

Hence, the specific objectives of this research are to:

- Review the IS and OA literature and explain the strategic role of ES in attaining OA;
- Identify relevant theoretical perspectives that underlie the relationship between ES and OA and/or IS and OA;
- Develop a conceptual framework linking ES and OA using relevant theory;
- Define the constructs that constitute the conceptual framework and develop measures to operationalise them;
- Collect data from organisations that have implemented and used ES;
- Empirically test the conceptual framework using the collected data;
- Identify the context factors that may moderate the impact of ES on OA; and
- Suggest contributions to theory and practice based on the research findings.

  The next section will discuss on the research approach to attain these objectives.

1.4 RESEARCH APPROACH AND ASSUMPTIONS

This research draws from the positivist perspective, which has been the dominant approach adopted in IS research. A quantitative method allows investigators to study a phenomenon without influencing it, or being influenced by it. Hence, quantitative methods are relevant to the conditions of positivist research, which requires taking a value-free position and employing objective measurements to collect research evidence (Walsham 1995). This study was conducted using a quantitative method, with a survey as the method of data collection.

The research model was empirically tested using data from large and medium Australian and New Zealand organisations operating in industries that are relatively dynamic and competitive, which have used ES such as ERP, CRM and SCM for at least a year. Survey respondents were chief information officers (CIOs) or equivalent senior IT managers who were expected to have knowledge on both their organisations' ES and business strategies. The collected data went through a data screening and a cleaning process to verify that the data satisfied the requirements for multivariate analysis.

An overall research model cannot be tested unless the measurement properties of the constructs are found to be reliable and valid. To establish initial reliability item-total correlation and Cronbach's alpha were used to examine if any item in the dataset was inconsistent with the average behaviour of the others. Validity checks if the instrument is measuring what it is supposed to measure (Straub et al. 2004). The validity of the measurement model was tested through content validity, factorial validity, construct validity (consisting of convergent and discriminant validity). The final reliability of the measurement model was tested through construct reliability and Cronbach's alpha. The results demonstrated that the measurement model satisfied the reliability threshold values. Overall, the analysis of the validity and reliability of the measurement model confirmed the appropriateness of the constructs and their indicators. After the measurement model was validated, the structural model was analysed for evidence supporting the theoretical model. The major emphasis in analysing the structural model validity was on variance explained (R^2), the significance of path estimates and the effect size (f^2).

Several assumptions were made for conducting this research. First, the focus of this study is on observing OA. The research assumes that in more dynamic environments, agility becomes a necessity and thus it can be observed more easily than in stable environments. Hence, data was collected from organisations that operate in industries that are considered as competitive and dynamic. Four industries—education, healthcare, agriculture and government—were assumed to have a stable business environment and were excluded from the data collection.

Second, the focus of this research is on the impact of ES. Therefore, only organisations that have implemented and used ES were observed. ES implementation is viewed as costly and the scope of its implementation is dependent on the complexity of the organisational. Furthermore, ES are typically provided as a packaged application from vendors and can be customised according to the organisation's scope and needs. For instance, SAP provides Business-One for small and medium size companies, while Business Suite is targeted to large organisations. Nevertheless, ES capability can only be fully deployed as well as appreciated on a larger scale. Hence, the second assumption made by this research is that only large organisations can exploit the full potential of ES, particularly for advancing agility, and such organisations provide a suitable setting to research ES competence. This assumption will be further explained in section 4.5.1.

Third, due to time-lag factor in the adoption of IT, the third assumption in this research is that a minimum of one year is needed to assimilate ES into organisational activities and observe organisational benefits.

Fourth, data were collected from organisations in both Australia and New Zealand. This research assumes that due to the similarity of the business context in these countries, such as the classification of their businesses and industries, as well as the close relationship between these countries in terms of their history and geography, respondents from these two countries were from the same population. This assumption was later tested via data cleaning in Chapter 5, and the results of the tests supported this assumption.

Finally, this research assumes that in large organisations, due to the importance of information in business activity, CIOs or equivalently senior IT managers belong to the top management team and are involved in designing organisational strategies. Using insights from the top management team and upper echelon theory (Hambrick & Mason 1984), it is assumed that CIOs are knowledgeable about ES management and the business benefits of ES.

1.5 FINDINGS OF THIS STUDY

The research findings reveal that the developed model explains 41.2 per cent of the variance in OA, 44.9 per cent of the variance in *ES-enabled sensing (ESS) capacity*, and 51.7 per cent of the variance in *ES-enabled responding (ESR) capacity*. Compared to the alternative model developed from the rival theory of the direct influence of ES competence on OA (see Chapter 7, Section 7.3), the research model demonstrates a higher explanation power. This implies that although ES directly contributes to OA, the impact is stronger when organisations use their ES to build and renew two dynamic capabilities: their ESS capability and their ESR capability. Several ES competencies were identified, including technical, human, managerial, vendor and functional aspects as antecedents for building ESS and ESR capabilities.

1.6 CONTRIBUTION OF THE STUDY

This research study contributes to the many aspects of the theory and practice of ES. First, through an extensive review of the literature, this study offers a comprehensive and deepened perspective toward the existing gaps in IS/IT and ES-enabled OA. Second, the thesis bridges the gaps identified in Section 1.2 by introducing two new constructs for IS and OA research: ESS capability and ESR capability, as well as explicitly theorising ES-induced competencies that can be exploited in developing these two capabilities. The ES-related competencies include technical, human, managerial, vendor and functional aspects. Third, putting these constructs (ESS capability, ESR capability, and ES competencies) into the proposed research model drawing from DCT and process-based theory, this research has provided a clear nomological structure linking ES with OA. Fourth, the research has developed a sufficiently validated research instrument that can be used in future research into ES competencies and ES-enabled organisational capabilities. Fifth, the model proposed in this study is an original contribution. Furthermore, the research provides empirical support for this model through model validation using primary data collected from the sample organisations. Sixth, the research provides empirical support to the application of DCT in measuring ES capabilities, since the majority of the current research only examines

ES from the resource-based view. Seventh, the study adds to the current body of knowledge on ES post-implementation benefits, because the majority of ES research focuses on implementation rather than post-implementation issues. Finally, the research identifies key lessons for practitioners in managing their organisations' ES for advancing agility.

1.7 STRUCTURE OF THE THESIS

The rest of the thesis is organised into eight chapters, which are structured as follows:

The next chapter, Chapter 2, reviews the literature on OA and identifies the common perspectives with respect to its relationship with IS in general, and ES in particular. First, the research examines the literature on OA to identify relevant concepts for understanding OA, and its underlying theories and determinants. The literature review highlights the 'what' of OA (flexibility and adaptability), the 'how' of OA (sensing, responding) and the context of OA (time and environment sensitivity) as well as the determinants of OA (strategy, resource, capability, design and management).

Second, the research reviews the IS and ES literature to identify different positions and theoretical perspectives on the relationships between ES and OA as well as IS and OA, and reveals several research gaps.

Based on the research background, Chapter 3 draws from dynamic capability theory (DCT) and process-based perspectives on OA as the outcome of sensing and responding processes to develop a framework. The constructs of the framework are identified, and hypotheses are developed on the relationships between the constructs.

Chapter 4 focuses on the research methodology that was used to gather the data for validating the proposed framework developed in Chapter 3. The chapter begins with a discussion of the relevant epistemological perspective, then covers the decisions and justification of the sample design, instrument development, data collection and data analysis methods. Specifically, this research study takes a positivist perspective, conducting a survey for collecting data and employing structure equation modelling (SEM) using partial least square (PLS) as the analytic approach.

Chapter 5 presents a discussion on the process of data preparation of the collected data. Data examination was undertaken in systematic steps which included testing the data for missing values, outliers, departure from normality, non-response bias, and common method bias. Relevant remedial steps were taken where necessary according to the results of each test. The chapter also provides a discussion of the respondent demographics.

Chapter 6 provides a discussion on measurement model validity and reliability. Specifically, the chapter covers the two procedures: (1) purifying the measurement scales and (2) testing for construct validity. For the first procedure, several tests were taken in sequence, involving content validity and factorial validity using exploratory factor analysis. For the second procedure, construct validity was tested with convergent and discriminant validity tests for both first- and second order constructs. The reliability of the constructs was also tested. The measurement model developed showed sufficient rigour and was used in the subsequent chapter for building the structural model and testing hypotheses.

Chapter 7 presents the testing of the hypotheses developed in Chapter 4, which were tested through the validation of the full structural model using PLS estimation, and reports upon the research findings. Chapter 8 provides an extensive discussion on the findings of the study in the context of the literature.

Finally, the thesis concludes with Chapter 9. The chapter begins with a reflection on the research findings in relation to the initial research questions to identify whether the study has achieved the set objectives. The chapter then presents a detailed discussion of the contributions of the research findings to the current body of knowledge as well as its implications for business. Lastly, the limitations of this study, areas for further research, and final concluding remarks are given, which concludes both chapter and the thesis.

CHAPTER 2: LITERATURE REVIEW

ORGANISATIONAL AGILITY, INFORMATION SYSTEMS AND ENTERPRISE SYSTEMS

2.1 INTRODUCTION

The aim of this research is to investigate the relationship between ES and OA. As such, it is important to understand the dependent variable, OA, in terms of its conception, sources, underlying theories and determinants. Specifically, this chapter will explore the domain of the OA construct, its definitions, and its determining factors. Furthermore, since ES is a subset of IS, different perspectives of OA from the IS literature will be examined. The review focuses particularly on the existing theoretical frameworks that link these two constructs. Likewise, the relationship between ES and OA is investigated within the same structure.

The chapter is structured as follows. It begins with a review of the literature on the concept of OA, presented in Section 2.2. This section introduces and provides understandings on the overall sources, historical development as well as prior definitions of OA. From this base, the review further focuses on identifying the determinants of OA, which are presented in Section 2.3. In Section 2.4, the relationship between IS and OA is investigated. This section then examines the different theoretical approaches used in IS research to understand OA. Section 2.5 further refines the relationship between ES and OA. A summary of the literature review is presented in Section 2.6.

2.2 THE CONCEPT OF ORGANISATIONAL AGILITY

The problem of how organisations can successfully deal with unpredictable, dynamic and constantly changing environments has been emerging as a topic of interest in both industry and academia for several decades. The 'agility' concept was first popularised in 1991 in a report entitled Twenty-first Century Manufacturing Enterprise Strategy (Goldman et al. 1991), presented by academics at the Iacocca Institute of Lehigh University. The academics were asked by the United States Department of Defence to work with industry to develop a vision of what a successful industrial base would look like and to develop a framework and recommendations to make that vision a reality (Kidd et al. 2004). From a manufacturing perspective, agility was defined as 'a manufacturing system with capabilities (hard and soft technologies, human resources, educated management and information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness)' (Yusuf et al. 1999).

After the first report on agility from Lehigh University, a number of researchers established the Agility Forum to explore further the agility concept. One of the achievements of the Agility Forum was to expand agility research from its initial direction in the manufacturing area into the wider business context. As a result, agility has become a topic of interest in different disciplines, such as operations and business strategic management (Galliers 2007; Lee 2004; Soule 2002; Sull 2009; Weill et al. 2002), human resource management (Breu et al. 2002; Dyer & Ericksen 2005; Dyer & Shafer 1999), supply chain management (Agarwal et al. 2007; Braunscheidel & Suresh 2009; Christopher & Towill 2001), and IS (Desouza 2006; Izza et al. 2008; Sambamurthy et al. 2003).

As OA is a research topic in various disciplines, there are many interpretations of what constitutes an agile organisation, causing confusion surrounding this concept (Li et al. 2008; Oosterhout et al. 2006). Notably, Oosterhout et al. (2006, p. 133) argue that although 'much has been said and written on' agility, a 'consensus on a definition of agility has not yet emerged'. Nevertheless, review of the literature shows distinct themes in describing OA: the 'what' of OA and the 'how' of OA. The first theme brings general ideas on the dimensions of OA. However, it provides limited guidelines on the mechanism by which OA is generated. The second theme fills the gaps of the first theme and avoids the confusion between OA and its most closely related concepts of flexibility and adaptability. Each of these themes is discussed next.

In the first theme, the concept of OA is derived from the performance characteristics of an agile organisation and is rooted in two related concepts; 'organisational adaptability' and 'organisational flexibility' (Sherehiy et al. 2007). Organisational adaptability focuses on how an organisation's form, structure, and degree of formalisation influences its ability to quickly adapt to its business environment (Sherehiy et al. 2007).

Organisational flexibility represents an organisation's capacity to adjust its internal structures and processes in a predetermined response to changes in the environment (Dove 2001; Yusuf et al. 1999). Adaptability underlies the fit of organisational operations to their environment, while flexibility emphasises the readiness of organisational resources and the ease of resource mobilisation. The 'agility' concept encompasses both flexibility and adaptability (Christopher & Towill 2001). Swafford et al. (2006b) define OA as a comprehensive ability to rapidly adapt. Sharifi and Zhang (1999) propose a model that introduces agility capability as including flexibility. An agile organisation is not only flexible to enable adaptation for predictable changes but also is able to respond and adapt to unpredictable changes quickly and efficiently (Dove 2005). In addition, OA is also closely associated with, and used interchangeably with, such terms as robustness, resilience, versatility, malleability, which were identified in prior studies as synonyms of flexibility and adaptability (Evans 1991; Ganguly et al. 2009; Golden & Powell 2000; Patten et al. 2005).

The definition of OA as an extension to the two preceding management concepts of organisational adaptability and organisational flexibility implies a continuous and incremental development in the way organisations cope with increasingly hyperactive and competitive environments. Nevertheless, because of the overlaps in the meanings of these concepts, the distinction between agility and the other synonyms (i.e., adaptability, flexibility) is not recognisable in many studies. For instance, Evans (1991) focuses on strategic agility and denotes that flexibility is the ability to do something other than what was originally intended, thereby emphasising the ability to respond to unforeseen changes as well. Hence, defining OA from this perspective causes confusion and ambiguity in understanding its conceptual domain.

The second theme takes a process perspective and defines OA by assessing how it can be achieved. Fundamentally, whenever encountering changes, every organisation needs to perform the two processes of sensing changes and responding to the changes they sense (Haeckel & Nolan 1996; Sharifi & Zhang 2001). Agile organisations are capable of performing these two processes more effectively and efficiently. Specifically, agile organisations excel in accurately sensing changes in their internal and external environments. Sensing refers to an organisation's ability to detect, capture and interpret organisational opportunities (Oosterhout et al. 2006; Seo & Paz 2008). Proactively sensing through systematically scanning the environment (i.e., looking for early indications of new ideas or trends, forecasting market movements) enables organisations to adjust to changes quickly (Tan & Sia 2006). Likewise, agile organisations excel in responding to changes efficiently and effectively in a timely and cost-effective manner.

Responding represents an organisation's ability to mobilise and transform resources to react to the opportunities that it senses (Gattiker et al. 2005; Oosterhout et al. 2006). Prior research emphasises that strong sensing and responding capabilities are critical to organisational success in turbulent environments (Overby et al. 2006; Haeckel 1999; Zaheer & Zaheer, 1997). These sensing and responding processes are inter-related. If organisations are unable to sense effectively, opportunities and threats remain unobserved and disregarded. This will limit the organisation's ability to take appropriate actions to respond to the opportunities and threats. Therefore, an organisation's sensing and responding capabilities should be aligned in order to effectively capture business opportunities by optimising organisational resources (Overby et al. 2006; Roberts & Grover 2012). Both Overby et al. (2006) and Roberts and Grover (2012) take the view that the alignment between sensing and responding comes from matching perspectives. This means that the stronger the match between customer-sensing capability and customer-responding capability, the greater the higher-level OA. From this perspective, sensing capability and responding capability are developed separately. However, sensing capability and responding capability are not separated, since they relate to each other through a sense-response-performance process (Haeckel 1999; Seo et al. 2006). Teece (2007, p.1343) argues that ‘an enterprise’s ability to manage competitor threats and to reconfigure itself is dependent on its investment activity, which is in turn dependent on its ability to sense an opportunity’. Hence, in addition to matching perspective, Roberts and Grover (2012) argue that the mediation perspective on the alignment of sensing capability and responding capability helps reveal insights of the sensing-responding-performance relationship.

In addition to the two fundamental processes of sensing and responding to changes, some studies stress the process of learning from the experience to improve the competencies of an organisation as a critical condition to maintain OA (Sambamurthy et al. 2003; Seo et al. 2006; Seo & Paz 2008). Learning refers to the ability of an organisation to acquire new knowledge based on its experience (Wang & Ahmed 2003). This capability allows organisations to continuously improve themselves and be better prepared to deal with changing conditions in their environments.

When examining context, OA places a strong emphasis on rapidity because in order to operate in a dynamic environment, speed is an essential quality (Sherehiy et al. 2007). Time has two critical dimensions in OA. First, it refers to the speed of detecting and responding to threats or opportunities. This includes the time to sense the events, the time to interpret what is happening and assess the consequences to the organisation, the time to explore options and decide on which actions to take and the time to implement appropriate responses (Tan & Sia 2006).

Second, it refers to the time that organisations retain competitive advantages before the advantages are imitated by competitors (Mathiassen & Pries-Heje 2006). However, there is no specific indication of how quickly the action should take place. To ensure that no threats or opportunities are missed, agile organisations require sensing and responding to changes to be quick and happen in real time (Pankaj et al. 2009; Seo et al. 2006). Real time does not necessarily mean a physical length of time (i.e., milliseconds or instantaneously). Speed should be understood within the time frame of available opportunities and competitors’ actions (Piccoli & Ives 2005). Agile organisations need to be quick, both in detecting opportunities and in taking and implementing actions. Changes happen unexpectedly and continuously in the business environment, hence, OA indicates a continuous process of aligning to changing business requirements. This process emphasises the importance of organisational learning from prior competitive actions (Sambamurthy et al. 2003).

Furthermore, the pressure of changes on organisations varies, and organisations have different levels of agility needs (Dove 2005; Oosterhout et al. 2006; Tallon 2008; Tallon & Pinsonneault 2011; Zhang & Sharifi 2000). Various explanations have been given to support this argument. Agility is a strategic objective that must be in balance with other objectives, priorities and organisational capabilities. Specifically, the OA level is constrained by the intuitive knowledge and values of change proficiency (Dove 2005). Hence, to be effective, OA levels must be developed to be consistent with the actual organisational needs and the reality of limitations in organisational capabilities. Sharifi and Zhang (1999) argue that different organisations are different in the way they should respond to changing business environments.

Organisations that operate in a dynamic environment require greater agility than those that operate in less turbulent business environments (Moitra & Ganesh 2005; Tallon 2008). The level of ED is dependent on both the sophistication of internal conditions as well as the turbulence of the external business environment (Oosterhout et al. 2006). Examples of changes in internal business environments are changes in organisational structure, or from acquisition or merging with other organisations. Changes in external environments can be seen in five areas: technology (e.g., new technology introduction), government rules and regulations, relationships with suppliers, customer preferences and competitors' actions. In agreement with this argument, Tallon and Pinsonneault (2011) provide a further explanation. In a volatile environment, failing to respond causes a more severe impact on organisational performance. In contrast, agility is less necessary in stable settings because there are fewer occasions to respond to changes, thus, there is less likelihood that agility will have a significant positive effect on firm performance (Tallon & Pinsonneault 2011).

To capture the common conceptions of OA in the management literature, Table 2.1 provides a matrix of the OA concepts used in the extant studies.

Table 2.1: Concept Matrix of Organisational Agility

Citation	The 'what' of OA		The 'how' of OA			Context of OA	
	Flexibility	Adaptability	Sensing	Responding	Learning	Speed	Environmental Dynamism
Ashrafi et al. 2005			X	X		X	X
Dove 2001, 2005			X	X	X	X	X
Ganguly et al. 2009		X		X		X	X
Hoek et al. 2001	X		X	X		X	X
Lee 2004		X		X		X	X
Menor et al. 2001	X	X				X	X
Nayyar & Bantel 1994		X				X	X
Sull 2009, 2010			X	X		X	X
Swafford et al. 2006b	X	X		X		X	X
Yang & Liu 2012			X	X		X	X
Yusuf et al. 1999	X	X				X	X
Yusuf et al. 2004			X	X		X	X
Zhang & Sharifi 2007	X		X	X		X	X

The summary of the domain concepts of OA in the literature captured in Table 2.1 provides two indications. First, regardless of the different perspectives on OA, the frequency of concepts appearing in various definitions indicates the dimensions that the domain construct of OA covers. Second, it suggests a dominant theme to define OA from the literature. The literature review shows that the prevailing conception of OA is based on the process perspective. Thus, in the current study, sensing and responding processes will be used to define OA.

2.3 DETERMINANTS OF ORGANISATIONAL AGILITY

Agile organisations require not only effective knowledge management and learning capability through data collection and analysis, but also efficient decision-making and quick deployment of solutions when responding to changes. Thus, agility involves all aspect of organisation architecture, such as technology, business processes, people, information and strategy. Likewise, various studies focus on agility from an overall organisational perspective (Arteta & Giachetti 2004; Dove 2005; Sambamurthy et al. 2003), or more specifically on particular areas of an organisation, such as workforce agility (Breu et al. 2002; Crocitto & Youssef 2003), strategic agility (Doz 2008; Weill et al. 2002), technology agility, business process agility (Seethamraju & Seethamraju 2009; Tallon 2008) or operational agility (Lee et al. 2009). Furthermore, since agility is related to many aspects of organisation, a number of researchers, including those in IS, have investigated what influences OA. Table 2.2 provides a review of the major perspectives of agility from the management literature, while Section 2.4 presents a review of the relevant IS literature.

Table 2.2 : Dominant Perspectives on Organisational Agility

Perspectives	Argument	References	Implications for current research
Strategy Content	The strategic stance and strategic actions that an organisation adopts determine OA. The type of agility strategies (e.g., quick, responsive, proactive) an organisation takes influence its agility level.	Dove 1999, 2001, 2005; Kidd 1997; Lin et al. 2006a; Sharifi & Zhang 1999; Sherehiy et al. 2007; Sull 2009; Zhang & Sharifi 2007	Organisations make decision on their agility strategies. The impact of ES on agility depends on the positioning of organisational strategy on agility.
Resource-based View	An organisation's tangible and intangible assets, competence, and procedures determine OA.	Breu et al. 2002; Sharifi & Zhang 1999	ES provides competences (e.g., flexible infrastructure, IS skills, vendor relationships) that influence the level of agility.
Capability-based View	The capability organisations develop in terms of responsiveness, flexibility, resilience and speed influence their level of agility.	Alexopoulou et al. 2009; Dove 2005; Haeckel 1999; Sharifi & Zhang 1999; Sherehiy et al. 2007	ES enables organisations to develop ES-induced organisational capabilities that generate agility.
Process-based View	Agility is the outcome of executing several processes.	Haeckel 1999; Seo & Paz 2008	ES can be used in the processes that result in agility.
Design and Management	Agility is influenced by the management (e.g., workforce, change, technology, innovation) and design (i.e., product design and manufacturing) practices of the top management.	Alexopoulou et al. 2009; Sherehiy et al. 2007	The management of ES and the design of ES influence agility.

As can be seen from Table 2.2, the six main perspectives of OA that can be identified from the literature are: (a) strategic content, (b) the resource-based view, (c) the capability-based view, (d) the process-based view, and (e) design and management.

The first perspective on OA comes from strategy content. Strategy content emphasises that organisations seek to align themselves with their environment (Meier et al. 2007). The agility literature that takes the strategic content perspective argues that the strategic stance and strategic actions that an organisation adopts determine OA (Dove 2005; Sharifi & Zhang 2001). Organisations operating in different business contexts will encounter changes differently. Hence, organisations vary in their needs for agility. The strategic positioning of organisations with respect to their business environment determines their strategy for agility, which in turn influences how their OA is developed (Sharifi & Zhang 1999; Sherehiy et al. 2007). More specifically, the literature identifies several types of agility strategies, including quick, responsive and proactive (Sull 2009; Zhang & Sharifi 2007). This perspective generates implications for the current research in that the impact of ES on agility is dependent on the positioning of organisational strategy on agility.

The second perspective comes from the resource-based view: that an organisation's tangible and intangible assets, competence and procedures determine OA (Breu et al. 2002; Sharifi & Zhang 1999). In particular, Sharifi and Zhang (1999) identify four areas of resources that agility can be developed from, which include technology, organisation, people and innovation. Breu et al. (2002) claim that an agile workforce enables agile organisations. Swafford et al. (2006a) report that flexibility in manufacturing and procurement/sourcing processes directly influences organisations' supply chain agility. Therefore, this perspective generates implications for this research study: that ES can be viewed as a source of resources which support organisations' advancing agility.

The capability perspective suggests that organisations attain agility through the possession and development of several distinguishing capabilities (Dove 2005; Lin et al. 2006b; Yusuf et al. 1999, 2004). These capabilities are related to four principle elements: (1) responsiveness, which is the ability to identify changes and respond quickly to them, (2) competency, which is the ability to efficiently and effectively reach aims and goals, (3) flexibility/adaptability, which is the ability to process different processes and achieve different goals, and (4) quickness/speed which is the ability to carry out activities in the shortest possible time (Lin et al. 2006b; Sharifi & Zhang 1999). From these four main elements, Zhang & Sharifi (2007) expand seven competitive capabilities: proactiveness, responsiveness, competency, flexibility, quickness and partnering. Consistent with capability view, Dove (2001, p.6) claims that 'agility does not come in a can', it needs to be developed by organisations through a set of organisational routines and processes and thus it is not a static asset or resource. This research study can extract several implications from the capability perspective of OA. First, ES is merely an organisations' static asset and does not bring OA benefits. Instead, the capability of ES in developing ES-induced organisational capabilities generates agility. Second, in the context of a continuously changing business environment, the capabilities generated by ES must be renewable, reconfigurable and regenerated to maintain sustainable OA.

From a process perspective, OA is the final outcome after conducting a set of business processes. More specifically, Haeckel (1999) specifies that the two fundamental processes in attaining OA are sensing and responding to changes from the business environment. Furthermore, the process perspective emphasises the sequential characteristics of the process workflow. Responding follows sensing; hence an organisation must sense a change, problem or opportunity before it can respond (Haeckel 1999). This process perspective generates implication for the current research in that ES can enable OA if it participates in and facilitates the processes that generate OA (i.e., sensing and responding).

The final perspective on OA from the literature is design and management. This perspective suggests that agility is influenced by the management (e.g., workforce, change, technology, innovation) and design (i.e., product design and manufacturing) practices of the top management (Sherehiy et al. 2007; Swafford et al. 2006a). Swafford et al. (2006a) identify that supply chain agility in an organisation is a manifestation of the interactions between the flexibility present in the procurement/sourcing, manufacturing, and distribution/logistics processes, which also constitute the key supply chain process elements. Alexopoulou et al. (2009) recommend that OA need to be assessed from a holistic perspective that covers all area of organisational architecture. The five viewpoints of organisational architecture are people, business process, organisational, information and IT (Alexopoulou et al. 2009). Hence, the management of any of these five areas affect the OA level. Gallagher and Worrell (2008) have examined the different agility demands at the business unit level and the organisational level. Specifically, business unit agility demands the ability to sense and respond to changes in local competitive environments, whereas OA demands the ability to sense broader market opportunities and respond with changes that are organisation-wide.

The former requires experimentation and customisation of system designs, while the latter demands uniformity and standardisation (Gallagher & Worrell 2008). Hence, to meet these challenges simultaneously, coordination across multiple business units also demands effective organisation and governance of system design and development (Gallagher & Worrell 2008). In order for an enterprise to maintain a high level of agility, it must have a rapidly adapting policy for its strategy and quickly drive important changes (Gebauer & Schober 2006). This design and management perspective provides an indication to the current study that ES needs agile infrastructure and must be managed in accordance with organisations' business strategies in order to attain OA.

As indicated above, a number of previous researchers have investigated the factors, processes, strategies, and structures that contribute to OA. Since the early stage of research into OA, IT and IS have been recognised as one of the most critical determinants of OA. Sharifi and Zhang (1999) suggest that IT/IS, with its competitive advantage of timeliness, communication ability and coverage, is a major differentiator of an agile organisation from its less agile rivals. However like many previous studies, this research focuses on agility of manufacturing organisations. Expanding beyond the boundary of manufacturing into general business, Oosterhout et al. (2006) suggest that IT is one of the six agility enablers/disablers: (1) business network government, (2) business network architecture,(3) IT, (4) organisation governance, (5) organisation architecture and (6) organisational culture and personnel. Therefore, the following section will focus on the OA and IS relationship in detail.

2.4 ORGANISATIONAL AGILITY AND INFORMATION SYSTEMS

Agility is not a static resource and 'does not come in a can' (Dove 2001). It must be developed by organisations when they combine different organisational resources. As IS bring benefits to organisational performance, including organisational flexibility (Shang & Seddon 2002), the role of IS in OA has attracted some research attention.

Contemporary organisations depend on their IS and IT; cannot survive or grow without IS support; and are investing to build their IT infrastructures while expecting better organisational performance in return (Mathiassen & Pries-Heje 2006; Peppard & Ward 2004). On the one hand, IS are widely acknowledged as an essential resource that either directly or indirectly merges with other organisational resources to help organisations gain a competitive advantage (Piccoli & Ives 2005; Powell & Dent-Micallef 1997; Ravinchandran & Lertwongsatien 2005). On the other hand, OA is viewed as a strategic option which enables an organisation to capture competitive advantage in a hypercompetitive and dynamic environment (Sambamurthy et al. 2003). Hence, there is strong interest in understanding the relationship between IS and OA.

This section offers a review of the IS literature. First, the concept of IS/IT is briefly discussed. Then the ways in which IS research conceptualises OA will be reviewed. This will be followed by a discussion of perspectives on IS and OA, including the theoretical perspectives.

2.4.1 The Concepts of Information Technology and Information Systems

From the literature, it is notable that the term 'information technology' is often used interchangeably with the term 'information system' (Alshawi 2001; Succi & Walter 1999; Willcocks 1994). However, the concept of IS is much broader than that of IT (Alshawi 2001). IS encompass a whole range of business processes that support the gathering of information from suppliers, and as such, involve human interaction. IS refers to a system that collects, processes, stores, analyses and disseminates information for the requirements of an organisation. This flow of information may involve formal or informal procedures, and be processed using computerised or non-computerised systems (Alshawi 2001; Succi & Walter 1999). IT refers to the technological side, including hardware, networks, software and other devices (Alshawi 2001). An IS is not the IT alone, but the system that emerges from the mutually transformational interactions between the IT and the organisation (Mingers & Willcocks 2004). Hence, in this research, IT and IS are used interchangeably to address a broader view of information management that cover both the technology (e.g., hardware, software, networks and devices) the human aspect (e.g., the IS staff, IS users) as well as the management aspects (e.g., the usage, maintenance and investment in IS).

Despite the above differences and similarities between IT and IS, a review of the IS literature on OA identifies two views of the IS infrastructure : (a) a technically-oriented view that considers IS as complex technical artefacts, and (b) a digital platform view that considers IS as a leveragable infrastructure (Sambamurthy et al. 2003; Fichman 2004). The first view promotes the idea that IS represent business processes that are 'hardwared' through rigidly predefined process flows (Desouza 2006; Izza et al. 2008). While this characteristic of IS stabilises and increases the efficiency and effectiveness of business processes, it nonetheless discourages business process modifications in the instance of change.

The second view emphasises that the adoption and use of IS in organisations is inseparable from business strategies and management capabilities. IS in this context is viewed as a digital platform that is incorporated with non-IT capabilities to control the information flow inside an organisation (Sambamurthy et al. 2003). These two views have led to contradicting conclusions regarding the role of IS in advancing OA. Before examining these views, the next section offers a discussion of how the IS literature defines the concept of OA.

2.4.2 The Concept of Organisational Agility in Information Systems Research

As indicated in Section 1.2, the IS literature is less clear in its treatment of the concept of OA vis-à-vis the two fundamental attributes of agility, that is, sensing and responding. A summary of OA definitions and its concept matrix in IS literature is presented in Appendix 2.1. The summary reveals that a larger number of the IS studies define OA to consist of two components: sensing and responding. However, the position of the two components varies differently in respect to OA.

Sambamurthy et al. (2003) view IS as a platform that can be leveraged to digitise processes and knowledge to create digital options which in turn enable OA. Entrepreneurial alertness, which consists of strategic foresight and systemic insight, moderates the impact of digital options on OA. Sensing and responding are not clearly located in the framework proposed in this study; however, Sambamurthy et al. (2003) argue that organisations exhibiting high entrepreneurial alertness can sense product-market discontinuities and visualise how organisational resources and capabilities can be orchestrated and exploited.

Overby et al. (2006) argue that by breaking the complex concept of agility down into its constituent parts of sensing and responding, agility can be observed and measured separately. This research posits sensing and responding inside the domain concept of OA and that they are not different from agility. In contrast, Seo and Paz (2008) treat sensing and responding as two sequential processes to achieve agility. They are the antecedents of OA. The output of sensing would become the input of responding and both of them are the input for the consequent OA. Thus, sensing and responding, although strongly related to, and able to influence agility, are different from agility.

Further, although the concept of IS-enabled OA is recognised in a few previous studies, what this concept actually means and its constituting parts lack definitional clarity. Researchers have used the concept to imply IT deployment agility (Tan et al. 2010), IT capability (Overby et al. 2006), and IS-enabled digital options (Sambamurthy et al. 2003).

Overall, the literature review indicates a lack of definitional clarity in constructing OA and a lack of theoretical consistency in positioning OA in relationships with IS from the IS literature.

2.4.3 Major Perspectives on Information Systems and Organisational Agility

The contribution of IS to making businesses agile as presented in the current literature is contentious because of the two distinctive views of the IS infrastructure, as discussed in Section 2.4.1, and lack of definitional clarity of what constitutes OA, as indicated in Section 2.4.2. For example, some argue that IS lead business processes to be ‘hardwared’ through rigidly predefined process flows (Desouza 2006; Izza et al. 2008). While this characteristic stabilises and increases the efficiency and effectiveness of business processes, it nonethless discourages business process modifications in the instance of change. Others argue that the adoption and use of IS in organisations is inseparable with business strategies and management capabilities. IS in this context is viewed as a digital platform that is incorporated with non-IS capabilities to control the information flow inside an organisation (Sambamurthy et al. 2003).

The two views (IS as a technical artefact vis-à-vis digitally leveraging) have led to contradictory conclusions regarding the impact of IS on OA. While the IS as a technical artefact view argues that IS, unless inherently agile, inhibit OA (Desouza 2006), the digitally leveraging view supports that IS are socio-technical systems and can be leveraged to support OA (Sambamurthy et al. 2003). Overall, the review of the literature on the link between IS and OA shows that there are three perspectives—the facilitating, inhibiting, and neutral perspectives. These three perspectives relate to the two distinctive views of IS infrastructure, that is, IS as a complex technical artefact versus IS as a leveragable digital platform. The inhibiting perspective comes mostly from the restricted scope of IS as an application artefact, while the neutral and facilitating perspectives are found in the research that integrates IS digital platforms along with complementary organisational capabilities. Table 2.3 provides a summary of these perspectives.

Table 2.3: Perspectives on Organisational Agility

Citation	Method	Main Argument/Finding	Perspectives on OA		
			Facilitate	Inhibit	Neutral
Breu et al. 2002	Survey	Availability of IS that provides consistent and accurate information and the uptake of new working models contribute to agility.	X		
Desouza 2006	Conceptual framework	Agile organisations and agile IS are the same thing.	X		
Elfatatry 2007	Conceptual framework	Delivering software as a service potentially increases business agility.	X		
Fink & Neumann 2007	Survey	IT personnel business, behaviour and technical capability support IT infrastructure capability, which in turn enables IT dependent OA.	X		
Francalanci & Morabito 2008	Survey	IS integration enables a higher degree of process orientation and overall organisational flexibility.	X		
Holmqvist & Pessi 2006	Single case study	Agility is nurtured by action through implementation and strategic awareness and by keeping projects small enough that it is possible to both comprehend and lead development.	X		
Lyytinen & Rose 2006	Conceptual framework	IS functions support organisational learning, exploration and exploitation, which enable OA.	X		
Melville, Gurbaxani	Panel data	Flexibility of IT enables response to rapid changes in the competitive	X		

& Kraemer 2007		environment.			
Moitra & Ganesh 2005	Exploratory research (interview)	Web services connect disparate applications, which enable flexible business processes and ultimately, organisational adaptation.	X		
Newell et al. 2007	Single case study	IS cannot promote agility because they are built to help enforce control and efficiency. Agility is spurred by chaos rather than control.		X	
Oosterhout et al. 2006	Conceptual framework	The nature of the agility gap influences the role of IS as either a facilitator or inhibitor of OA.			X
Overby et al. 2006	Conceptual framework	IS mismanagement, rather than IS per se, is the main influence on OA.	X	X	X
Sambamur-thy et al. 2003	Conceptual framework	IS competencies and entrepreneurial alertness enable digital options, which together enables agility.	X		
Seo & Paz 2008	Conceptual framework	IS capture large amounts of data, from multiple sources, in multiple formats, and make the data accessible to enable sensing capability of organisations.	X		
Tallon 2008	Survey	Information legacy systems can be inflexible or unresponsive to change.		X	
Weill et al. 2002	Conceptual framework	Right balance of investment in high-capability IS infrastructures enables strategic agility. Imbalanced investment leads to waste of resources.	X	X	X
Zain et al. 2005	Survey	IS acceptance directly and indirectly enables OA	X		

2.4.3.1 Information systems facilitate organisational agility

The facilitating perspective argues that OA is directly or indirectly associated with IS. Results from a survey (Zain et al. 2005) involving 329 managers and executives in manufacturing firms in Malaysia showed that actual system or technology usage had a strong direct effect on OA. Meanwhile, perceived usefulness and perceived ease of use of IT influenced OA indirectly through actual systems or technology use and attitudes toward using the technology (Zain et al. 2005). Desouza (2006) opines that agile organisations and agile IS are the same thing, due to the dependency of contemporary organisations on their IS from the operational to the strategic management levels. He argues that agile IS enable agile organisations and vice versa. From that perspective, an agile IS must be able to align IS architectures with the changing information needs of an organisation when responding to changes. IS have the capability to quickly compile and analyse data and information, streamline and automate business processes without any effort as well as build inter-organisational relationships (Lee et al. 2007; Seo & Paz 2008). Wade and Hulland (2004) found that IS enables firms to track shifts in customer choices much more rapidly, hence enabling organisations to quickly react to changes in customer preferences. IS support for organisational learning, exploration, and exploitation is a critical enabler of OA (Lyytinen & Rose 2006).

Further, the availability of IS that provide consistent and accurate information and the uptake of new working models has a positive association with creating agility (Breu et al. 2002). Sambamurthy et al. (2003) argue that the transformation from the traditional economics of physical components to digital economics demonstrates the enabling effect of IT/IS on OA. IS competencies and entrepreneurial alertness provides digital options that are generated through the digitisation of knowledge and the business processes, which in turn facilitates agility. Researchers in new product development (Pavlou & Sawy 2010) identify the IS-leveraging capabilities that are reflected through three IS systems as (1) project and resource management systems, and (2) organisational memory systems and cooperative work systems that facilitate the organisation’s ability to spontaneously reconfigure existing resources to build new operational capabilities to address urgent, unpredictable and novel environmental situations.

Scholars advocating the facilitating perspective of IS on OA share a common argument that the alignment between IS and business process is the most essential element that moderates the positive contribution of IS to OA. The IS development effort to align the IS with process changes on a dynamic basis allows every decision for a change to be implemented in the system immediately, thereby facilitating agility (Olsen & Sætre 2007). OA also requires IT infrastructure flexibility. IT infrastructure flexibility generates information building, and this directly impacts a firm's ability to respond to environmental change (Bhatt et al. 2010). Similarly to the other key areas of an organisation, flexible IT infrastructure enables organisations to respond quickly to strategic moves by competitors (Byrd & Turner 2000). Fink and Neumann (2007) signify a positive effect of IT-dependent system agility on IT-dependent information agility, and of both on IT-dependent strategic agility. IS infrastructure flexibility maintains a certain level of standardisation and works as a business platform that is capable of introducing changes throughout the organisation *en masse* (Gallagher & Worrell 2008). An integrated IT infrastructure enables an organisation to share information, coordinate activities and align processes with its partners while IT reconfiguration enables an organisation to accommodate new applications and reduces the effort the firm needs to change or recombine resources to support its evolving requirements for managing its inter-organisational relationship portfolio (Rai & Tang 2010).

2.4.3.2 Information systems inhibit organisational agility

The inhibiting perspective maintains that complex IT architecture may hinder organisations from being agile (Newell et al. 2007; Tallon 2008). For example, Newell et al. (2007) argue that IS cannot promote agility because they are built to help enforce control and efficiency. Agility, on the other hand, is spurred by chaos rather than control and efficiency. As discussed earlier in this chapter, OA means having more options than those that have been preset. However, IS can be optimised only in situations when the process is well defined. The balance between control and flexibility is not always set at the optimal level; hence, IS may inhibit agility in certain circumstances. Tallon (2008) points out that once an IS is implemented, it will soon become a legacy system, while technology keeps developing. Legacy systems reduce flexibility and innovation, and restrict rather than release the improvisational skills of users as they confront new and unpredictable situations. Seo and

Paz (2008) indicate that IS that are built at a certain point are relevant to solve specific problems that were important at that given time. The dynamic business environment can cause the IS to be out of date for the needs of future business conditions. This is particularly the case in large organisations which are entangled in large, complex IS with hard-coded embedded business processes and complex linkages between applications, which are developed separately by different IS vendors (Oosterhout et al. 2006). Changing requirements in such IS takes a considerable time and much effort to implement and shrink the IT budget to be spent on innovation, which is the main provider of OA. Although tight IT integration (e.g., collaboration with business partners) streamlines and speeds up the automation of business processes, it discourages any modification that may become essential in the case of changing business requirements (e.g., increases technological switching cost) (Rai & Tang 2010).

A flexible IT infrastructure allows an organisation to respond to environmental change (Fink & Neumann 2007). On the contrary, an inflexible IT infrastructure inhibits a firm's ability to respond to market opportunities, due to delays or rushed implementation and limited information sharing (Bhatt et al. 2010; Weill et al. 2002). Legacy systems are often rigid, which also limits an organisation's ability to respond to external opportunities. Furthermore, attempts to upgrade such systems often lead to performance issues without an increase in flexibility (Bhatt et al. 2010).

2.4.3.3 The neutral view of information systems and organisational agility

The neutral view maintains that IS can either enable or inhibit OA, depending on the existence of agility gaps that are generated by IS and the nature of IS management in place (Oosterhout et al. 2006). OA gaps refer to the difference between the level of agility required and achieved. Overby et al. (2006) point out that, like other organisational resources, IS mismanagement, rather than IS per se, is the main factor that negatively influences OA. Without appropriate IS governance, IS will inhibit instead of enable an organisation's agility. Furthermore, Mondragon, Lyons and Kehoe (2004) signify that poor support of IS to operations does not necessarily determine the level of agility achieved and is not an impediment for developing agility. Companies, especially those in the manufacturing sector, rely on non-IT attributes to improve the agility of their operations.

Therefore, IS should be considered secondary or as second order enablers of agility involving the enhancement of agile business processes. First order enablers are used during the first phase of the development of agile business processes (Mondragon et al. 2004). Moitra and Ganesh (2005) also postulate that flexible business processes are a key determinant of organisational adaptation or OA.

The review of research on the impact of IS on OA presented in Table 2.2 indicates an inconclusive outcome on the role of IS on OA and the scarcity of empirical evidence for both sides of the argument. Nevertheless, the existing knowledge provides a general domain for the research on the impact of ES on OA. The next section reviews the theories that research on IS and OA have employed for explaining this relationship.

2.4.4 Theories Used in Information Systems Literature on Organisational Agility

In identifying the various IT/IS antecedents of OA, researchers typically draw from one or more of the resource-based view (RBV), Dynamic Capability Theory (DCT), knowledge-based view (KBV), and process-based view (PBV); see Table 2.4 for a summary.

Table 2.4: Dominant Theoretical Perspectives in the Information Systems and Organisational Agility Literature

Citation	RBV	DCT	KBV	PBV	Other	Methodology	IS-Enabled OA Antecedents
Ashrafi et al. 2005, 2006		X	X			Conceptual	IT capabilities of managing knowledge: knowledge acquisition, knowledge distribution, knowledge identification, knowledge upgrading.
Bhatt et al. 2010	X		X			Empirical	Infrastructure flexibility, information dissemination, information generation.
Fink & Neumann 2007	X					Empirical	Flexible IT infrastructure (IT personnel capabilities).
Lee, Lim & Wei 2004		X				Empirical	IT dynamic capability building through process improvement or

							innovation, IT dynamic capability creation through innovative adoption of new IT capabilities.
Lee et al. 2006	X					Conceptual	Agile IT strategy, agile project management, agile IT infrastructure.
Overby et al. 2006		X		X		Conceptual	IS-enabled sensing capability, IS-enabled responding capability.
Sambamurthy et al. 2003		X				Conceptual	IT competence (investment scales, IT capabilities), digital options (process reach, process richness, knowledge reach, knowledge richness).
Seo & Paz 2008				X		Conceptual	Anecdotal example of IT/IS systems and technologies that support business functions in the process of pursuing OA.
Tallon 2008	X					Empirical	Managerial IT capabilities (IT-business partnership, strategic plans for IT use, post-implementation reviews), technical IT capabilities (hardware compatibility, software modularity, network connectivity, IT skills adaptability).
Wu, Gang & Zengyuan 2006	X					Conceptual	Internal integration, business process redesign, strategic revolution.
Zain et al. 2005					TAM	Empirical	Actual system or technology usage, perceived usefulness and perceived ease of use of IT.

Some studies (Fink & Neumann 2007; Tallon 2008; Bhatt et al. 2010) seek the antecedents of OA from an RBV. The RBV postulates that organisational resources that are valuable, rare, inimitable and non-substitutable (VRIN) are able to create organisational competitive advantages (Barney 1991). Resources are valuable when they enable organisations to implement strategies that create a competitive advantage or sustained competitive advantage (Barney 1991a). Resources are considered rare when they are not simultaneously available to a large number of organisations; hence, creating competitive advantage to those which obtain the resource. An organisation that obtains valuable and rare resource can obtain competitive advantages. However, those competitive advantages can only be sustained if the resource is at the same time inimitable (Barney 1991a, 1991b).

According to Barney (1991b), a firm's resources are imperfectly imitable if they have unique firm history, causal ambiguity and social complexity. The history of an organisation is the past and is difficult to duplicate. Causal ambiguity exists when the link between a resource and the competitive advantage it confers is poorly understood. This ambiguity might be in how an organisation chooses its resource (or combination of resources) or how a resource leads to sustained competitive advantage. Hence, such causal ambiguity makes competitive advantages difficult to duplicate by other organisations. Social complexity refers to the context in which an organisation's resources may be imperfectly imitable because they are generated from complex social relationships between the organisation and its stakeholders. These relationships are beyond the ability of other organisations to systematically imitate (Barney 1991a). Lastly, a non-substitutable resource means that there must be no strategically equivalent valuable resources that are either not rare or imitable.

Two mechanisms of resource picking (identifying or creating resources) and capability-building (building unique capabilities from the resources) transform organisational resources into capabilities that support organisational competitive advantage (Makadok 2001). The RBV view only focuses on the resource-picking mechanism and argues that organisations capture competitive advantage if they can discern which resources are the winners (i.e., from criteria of being valuable, rare, inimitable and non-substitutable) and which resources are the losers (Makadok 2001). Arguably, agility is a type of organisational competitive advantage and involves all areas of organisational architecture. Thus the RBV allows organisations to identify the resources that enable agility from a holistic view of the overall organisation. The two mechanisms of resource picking and capability building explain how OA can be obtained. Within the IS field, researchers argue that an IS is one type of organisational resource that can be leveraged to enable OA. They postulate that IS resources operate in synergy with other complementary organisational capabilities to enable OA. Various types of IT- and IS-related resources that enable OA are identified in the literature. These include the technical, behavioural, and business capabilities of IT personnel (Fink & Neumann 2007), flexible IT infrastructure (Bhatt et al. 2010), IT system characteristics and IT applications (Gattiker et al. 2005; Goodhue et al. 2009), managerial IT capabilities (IT-business partnerships, strategic planning and ex-post IT projects) (Tallon 2008), agile IT strategy and agile project management (Lee et al. 2006).

Extending from the RBV, other researchers (Sambamurthy et al. 2003; Lee et al. 2004) took a DCT-based view to explain how OA can be achieved through IS. Instead of merely identifying the VRIN attributes, as in RBV, these studies argue that maintaining sustainable OA requires a continuous process of resource identification and leveraging.

Thus, the DCT-based view, which emphasises the reconfigurability and renewability of resources in maintaining sustainable competitive advantage, can explain OA more precisely. IT/IS resources can be leveraged to provide dynamic capabilities. To illustrate, digitisation of business processes and knowledge provide digital options that enable organisations to adapt to changing requirements more quickly by changing information-based value propositions, forging value-chain collaborations with partners and rapidly exploiting market niches (Sambamurthy et al. 2003). In more detail, the DCT-based view implies that through resource-picking and capability building under the moderating impact of strategic foresight, system insight and organisational learning, which act as a leveraging mechanism to generate IT-enabled capabilities from the IT competence, allows a firm to obtain agility.

The third group of studies explains OA from a knowledge-based view (Ashrafi et al. 2005, 2006). Agility is possible only if an organisation is capable of recognising and assimilating changes rapidly. To do so, organisations need to maintain alertness to market changes, assess internal and external knowledge and exploit this knowledge and disseminate knowledge internally to the relevant decision makers. Therefore, the process that obtains agility is actually the process of managing knowledge within an organisation. Since IS help to manage information throughout an organisation, IS play a crucial role in facilitating the gathering of market intelligence and providing collaborative work processes that augment agility. The mechanisms by which OA can be achieved from IS consist of the IT/IS capabilities of knowledge acquisition, knowledge distribution, knowledge identification and knowledge upgrading (maintenance).

Finally, a number of studies develop models surrounding the definition of OA as the ability of an organisation to sense environmental changes and respond effectively to the changes from the PBV. Three key processes are identified in pursuing agility. These are the processes of sensing changes in the internal and external environment, responding to changes effectively in a timely and cost-efficient manner, and learning from the experience to improve the competencies of an organisation (Seo & Paz 2008). Sensing refers to an organisation's ability to detect, capture, and interpret organisational opportunities (Oosterhout et al. 2006; Seo & Paz 2008). Proactively sensing through systematically scanning the environment (i.e., looking for early indications of new ideas or trends, forecasting market movements) enables organisations to adjust to changes quickly (Tan & Sia 2006). Responding represents an organisation's ability to mobilise and transform resources to react to the opportunities that it senses (Gattiker et al. 2005; Oosterhout et al. 2006). Learning refers to the ability of organisations to acquire new knowledge based on their experience (Wang & Ahmed 2003). In the IS field, IT/IS has been found to strongly facilitate the sensing and responding processes through the creation of a digital option, thus enabling OA (Haeckel & Nolan 1996; Overby et al. 2006; Sambamurthy et al. 2003). For example, the adoption of RFID technology provides current information on product management (e.g., the rapid detection of errors in products), hence the technology directly and positively impacts OA (Zelbst et al. 2011).

While these four theories have been extensively used, a single theory does not provide a complete framework that explains how OA can be achieved. For instance, a KBV focuses only on an organisation's ability to manage knowledge, whereas OA refers to an organisation's ability to manage change. The responding component of OA needs to use the newly acquired and assimilated knowledge; it emphasises the consequent actions and their effects rather than the input knowledge. The RBV and DCT-based views focus on the drivers and factors influencing the implementation of agility. However, the leveraging process (resource picking and capability building) in the RBV and DCT-based view is too abstract to explain why certain capabilities make a substantial impact on the agility level of organisations. Likewise, the PBV alone does not illustrate the drivers and factors influencing the implementation of agility. As such, there is a gap in the existing literature regarding a framework that could explain the mechanisms by which IS impact on OA.

In summary, in this section, different perspectives on the link between IS and OA have been reviewed. The results indicate that various research theories have been employed to explain this relationship. Nevertheless, the review of the IS literature shows inconclusive arguments regarding this relationship. In the next section, the relationship between ES and OA reported in the literature and the domain of the current research study are discussed.

2.5 ENTERPRISE SYSTEMS AND ORGANISATIONAL AGILITY

IT has become a major component in enabling the competitive advantage of many organisations. Advances in IT, such as integrated networking and enormous data storage capacity, allow information to be accessible by all users in a timely manner. As IT becomes more and more closely associated with an organisation’s business, ES inevitably appear as the result of the integration between business and IT, and have been driven by the collaboration and co-evolution between them (Lorincz 2007). Thus, ES carries characteristics of both IT and business organisation. The concept of ES has evolved over the more than 50 years since the introduction of computers into business (Table 2.5).

Table 2.5: The Evolution of Enterprise Systems (adapted from Moller 2005 and Lorincz 2007)

Decade	Concept	Function
1950	Inventory control system (ICS)	Forecast and inventory management
1960	Material requirement planning (MRP)	Automatic requirement calculations
1970	Manufacturing resource planning (MRPII)	Closed-loop planning and capacity constraints
1990	Enterprise resource planning (ERP)	Integrated processes

The first ES application in business, the inventory control system (ICS), was used to manage inventories. It gradually evolved to standardised material requirement planning (MPR), which integrated the data and model level inventories to automatically plan, build and purchase requirements based on the inventory level. This is an advance in comparison to ICS due to the capability to proactively evaluate and forecast the inventory level and manage it more efficiently. However, because of the limitations in computer capabilities, calculations including more variables in inventory management, such as idle time, maintenance and labour, could not be accommodated in the system.

Manufacturing resources planning (MRPII), which integrates business planning, sales, distribution and supply logistics and other functions, expands the system capability and allows closed-loop planning. Since each of the preceding systems focused on manufacturing, the later IS development expanded its scope to different business areas. The introduction of ERP in the early 1990s allowed various business areas such as finance, accounting, planning and so on to be integrated into a sole system.

ERP is standardised software packaged designed to integration the internal value chain of an enterprise. ERP differs from MRPII in its technical requirements. In addition, ERP is an accounting-oriented IS with a focus on customers, while MRPII mostly focus on logistics and internal variables. ERP carries benefits such as integrated data and applications, implementation of a generic business model based on best practice, standardised solutions for business problems, a modularised structure and opportunities for customisation. At the same time, it also has some serious problems, including a monolithic system without process or work-flow management; limited customisation; a relatively inflexible application; failure to address real work constraint sufficiently; packaged or off-the-shelf application, demanding intensive consulting and expert IT support; assumptions of infinite capacity and inflexible scheduling dates. These problems result from the complex nature of IS.

Although research that explicitly investigates the relationship between ES and OA is rare (Table 2.6), the existing literature, similar to the more general IS and OA literature tends to be equivocal on the relationship between ES and OA.

Table 2.6: Summary of Literature on Enterprise Systems and Organisational Agility

Citation	Method	Main Argument/Finding	Perspective on OA		
			Facilitate	Inhibit	Neutral
Davis 2005	Conceptual framework	Conceptual link between ERP customisation and strategic agility.			X
Gattiker et al. 2005	Case study	The characteristics of ERP, i.e., built-in flexibility, process and data integration, and consultant knowledge, supports agility.	X		
Goodhue et al. 2009	Case study	The built-in solutions and third party add-ons of ES provide more options for responses to meet agility.	X		
Ignatiadis & Nandhakumar 2007	Single case study	Introduction of ES impacts on power differentials and drift within an organisation, resulting in either a decrease or increase of organisational resilience respectively.			X
MacKinnon et al. 2008	Survey	ES can either support or constrain aspects of strategy management and the flexibility of strategic, operational, human capital and information.			X
Newell et al. 2007	Single case study	ES is used for introducing efficiency and control rather than agility.		X	
Seethamraju & Seethamraju 2009	Single case study	ES integration, best practice, business process orientation, and standardisation promote business process agility.	X		

2.5.1 Enterprise Systems Facilitate Organisational Agility

A number of researchers have suggested a positive relationship between the use of ES and OA. An increase in OA is one of the benefits brought about by ES implementations (Davenport 1998). First, due to the advancement in ES applications and technologies, ES can speed up activities, provide intelligent and autonomous decision-making processes, and enable collaborations and distributed operations (Huang & Nof 1999). All three activities lead to agility (Holsapplea & Sena 2005; Huang & Nof 1999). Second, ES contain mechanisms such as built-in flexibility, process integration, data integration, and availability of 'add-on' software applications to support agility (Gattiker et al. 2005). Seethamraju and Seethamraju (2009) identify three types of ES integration—vertical, horizontal, and technical.

Vertical integration refers to integration between different hierarchical levels. Horizontal integration refers to integration between departments or functions within an organisation. Technical integration refers to integration between different systems in order that they are compatible with one another. Among the three types of integration, vertical integration, which enhances the visibility, accessibility, control and decision support capability, enables top management to better understand the critical need for changes, and thus supports agility. Huang and Nof (1999) also argue that if the definition of agility is concerned with an ES that consists of multiple, flexible, and cooperative subsystems, the whole system may still provide high agility. A study of 15 large organisations that have implemented and used ES (Goodhue et al. 2009) identified that when facing changes in their business environment, 39 per cent of these organisations, accounting for the largest proportion, would seek a response from the prebuilt business process implemented within their ES. In addition, the availability of system add-ons that have been developed to serve special functionalities creates a wide range of different capabilities that firms can attach to their backbones to meet their unique needs and respond to agility challenges (Goodhue et al. 2009). Moreover, through the availability of built-in and add-on functionalities, ES provide more options for responses to meet agility challenges that do not require changing the backbone of a tightly integrated program code (Goodhue et al. 2009). Hence, built-in and add-on solutions can be viewed as one source of agility that ES provide to organisations.

Flexible enterprises require ERP systems that enable mass customisation of business practices so that organisations can develop and maintain operational and strategic distinctiveness (Lengnick-Hall et al. 2004). Previous ES were developed based on tight coupling between business process components and business processes. Tight coupling of applications is more economical and faster to execute as well as relevant to operation in predictable environments (Moitra & Ganesh 2005). However, as the business processes are tightly coupled, it creates difficulty for rapid adaption. This is because any change made to one process affects many others. As the need for agility increases, there is a corresponding need for ES to become reconfigurable; hence the need for loosely coupled architecture. Likewise, the ES ecosystem has been undergoing a paradigm shift (Bardhanet al. 2010; Lorincz 2007).

ES vendors are innovating their software products by providing new versions of ES. For example, SAP's ERP systems have been developed from R3, through ECC6 to business Suite 7.0. This is an incremental and continuous development without radical modification of the core ES. Moreover, vendors have developed the Web Services (WS), service-oriented architecture (SOA), and business process management suites (BPMS). The introduction of WS, SOA and BPMS have increased the flexibility of ES infrastructures and changed ES capabilities (Moitra & Ganesh 2005; White, Daniel & Mohdzain 2005). The interface among the IS networks is increasingly becoming plug-and-play. This allows better internal collaboration within an organisation, as well as between an organisation and its external partners (Konsynski and Tiwana 2004). Loose coupling, a fundamental characteristic of WS, SOA and BPMS, is becoming embedded into the development of ES. Such development is making ES agility-enabling applications (Chen, Zhang & Zhou 2007).

2.5.2 Enterprise Systems Inhibit Organisational Agility

The general benefits of ES are (a) integrating data and applications, (b) implementing generic business models based on best practice, (c) providing standardised solutions for business problems, and (d) building on modularised structures (David, McCarthy & Sommer 2003; Devadoss & Pan 2007; Lorincz 2007). Despite these benefits, ES are viewed as organisational control systems that enable organisational efficiency rather than promoting OA. Some authors claim that ES have a negative impact on agility because their tight integration makes any process change more difficult (Newell et al. 2007) and their lack of functional fit with business requirements (Ni, Kawale & Ran 2002). Tight integration between different parts of the business may increase the complexity of the system as well as the whole organisation (Goodhue et al. 2009).

The more complex an organisation, the more difficult it becomes to restructure when that organisation needs to change. Further, the costs and risks involve in changing ES increase as well, since it is not possible to know how a change in one part of the software will affect its functioning elsewhere (Rettig 2007). Customisation of ES, resulting from the lack of fit between organisationally-owned business processes with standard processes provided by ES vendors, brings additional complexity, which may reduce OA (Davis 2005). In addition, although there is some evidence that ES allows firms to develop their business processes to closely match the current business environment, some of the evidence for positive impacts has come from organisations whose business environment is relatively stable. Efficiency and cost reduction, the fundamental benefit of ES adoption, may reduce OA (Galliers 2007; Newell et al. 2007).

2.5.3 The Neutral View of Enterprise Systems and Organisational Agility

Finally, a few researchers have introduced a neutral conclusion on the role of ES in OA. The introduction of an ES creates power differentials, which serve to increase control in the organisation (Ignatiadis & Nandhakumar 2007). This results in increased rigidity and a possible decrease in organisational flexibility and resilience. On the other hand, ES can also cause drift, resulting from the unexpected consequences of these power differentials, as well as from the role of perceptions of people in solving a problem within the ES. This reduction in control may serve in some circumstances as an enabler of organisational resilience (Ignatiadis & Nandhakumar 2007). The research findings suggest that there should be proper management of enterprise systems since they can increase or decrease organisational resilience.

Table 2.6 provides a summary of the literature on ES and OA. Most of the studies listed in Table 2.6 were exploratory, using a single case study. Overall, the literature so far has not provided a rigorous framework that shows the mechanisms by which organisations can become agile and remain so by exploiting the power of ES. In the next section, such a conceptual framework is presented.

2.6 CHAPTER SUMMARY

The purpose of this chapter was to review the literature on OA and to identify the common perspectives with regard to its relationship with IS in general and ES in particular.

The literature review has revealed two distinct themes in constructing OA. The first theme is rooted in the performance characteristics of an agile organisation, while the second theme, which is also the dominant one, defines OA from how it is constructed. From the second viewpoint, the key components of OA are identified as sensing, responding, time, and environmental context. However, while some studies (e.g., Overby et al. 2006) treat sensing and responding as components of agility, others take a process (Seo & Paz 2008) or capability (Sambamurthy et al. 2003) view and treat sensing and responding separately from agility.

How IT/IS influences agility is a topic of interest in IS research. Yet, the IS literature has not been very clear with respect to the conceptualisation of OA: IT-enabled OA and the 'IT artefact'. Further, the literature is inconclusive about the relationship between IS/IT and OA. Some view the role of IS on OA as that of a facilitator; others consider it to be an inhibitor.

Likewise, the literature on the ES and OA is divided between three perspectives: as facilitating, inhibiting and neutral views. ES, which capture the most advanced development of IT, are becoming common fixtures in most organisations. ES can improve organisational performance. However, the literature on ES is still dominated by ES implementation issues rather than post-implementation issues (Moon 2007). As such, how ES affect OA has been less researched.

In summary, it can be argued that these contradictory conclusions on the relationship between ES and OA in the existing literature are due to the lack of a mechanism that explains the impact of ES on OA. The previous studies mostly examine IS in general, and ES in particular, as resource providers. However, Shang and Seddon (2002) suggest that ES benefits are indirectly linked with business benefits through the use of information, rather than ES itself, and that ES mismanagement is the main reason that negatively influences OA (Overby et al. 2006). Further, most of the studies listed in Table 2.4 were exploratory in nature, using a single case study. Overall, the literature thus far has not provided a rigorous framework that shows the mechanisms by which organisations can become and remain agile by exploiting the power of ES.

In the next chapter, the specific domain of the constructs of ES and OA, as well as their relationships, will be further explored. Relevant propositions that hypothesise the ES–OA relationship will be presented. Drawing on the background discussion, a conceptual framework will be proposed that aims to address the research gaps identified in this chapter.

CHAPTER 3: CONCEPTUAL FRAMEWORK

3.1 INTRODUCTION

Chapter 2 reviewed the literature on the domain of OA which include its definition, dimensions, as well as its determinants. The review reveals that IS is one of the critical resources that have been recognised as affecting OA. However, the review of the literature identified three different perspectives on the relationship between IS and OA; the facilitating, inhibiting and neutral views. A review of the ES literature unveiled the same results with regard to this relationship. In addition, it also showed that the research on ES and OA is not only scant in terms of quantity, but also lacks both a theoretical framework as well as an empirical base. Therefore, this chapter is dedicated to the objective of proposing a theoretical model that could explain the mechanism of how organisations use ES to promote their agility.

The structure of the chapter is as follows. In Section 3.2, the research model, built from the literature review on the relationship between IS and OA, is proposed. The research model adopts the DCT-based and the process views of OA. Each of the constructs that made up the model, their definitions and the nomology that links them with one another and with OA will be discussed in Sections 3.3–3.8. Specifically, Section 3.3 discusses OA. Section 3.4 discusses the newly proposed construct of ESS capability, its definition and conceptual domain, as well as its hypothesised relationship with OA. Likewise, the construct ESR capability and related hypotheses are presented in Section 3.5. The alignment of ESS and ESR is discussed in Section 3.6. Section 3.7 presents the conceptual domain of ES competence (ESC) and its relationship with ESS and ESR. The environmental factors and their impact on these constructs as well as the overall framework will be discussed in Section 3.8. Finally, Section 3.9 provides a brief chapter summary.

3.2 THE RESEARCH MODEL

The literature review in Chapter 2 reveals three contradictory perspectives on the impact of IS and ES on OA: as a facilitator, an inhibitor, or a neutral influence. Each perspective is supported by logical and rational arguments. Nevertheless, the dominant perspective is the view of ES and IS as enablers of OA. Hence, the central argument of this research's conceptual framework (Figure 1) is in line with the facilitating view of IS/ES and OA. However, it is argued that the impact of ES on OA is not direct. Rather, organisations need to transform ES resources to develop an agility-enabling ES capability. To understand the structure of these resources and capabilities, this study will draw from the DCT and the PBVs of OA.

The DCT-based view is an extension of the RBV (Teece et al. 1997). The RBV emphasises the procedure of identifying and selecting the resources that fulfil the VRIN attributes of being valuable, rare, inimitable, and non-substitutable (see Chapter 2, Section 2.4.4). The RBV argues that organisations are fundamentally heterogeneous in terms of their resources and internal capabilities (Barney 1991a). If an organisation's resources meet the requirements of these four conditions, they are potentially able to generate a sustained competitive advantage (Barney 1991a). The RBV has been criticised for disregarding the impact of the business environment and for assuming that organisations' resources simply exist and are intact (Teece et al. 1997; Wade & Hulland 2004). Contemporary organisations cannot rely only on their available stock of resources to maintain competitiveness in the context of an increasingly instable business environment (O'Connor 2008). In addition, the RBV does not explain how resources are integrated and released within a firm. DCT fills this gap by introducing the capability concept, which integrates resources with the strategy to manipulate them in order to generate competitive advantage (O'Connor 2008).

The DCT-based view regards firms' ability to constantly adapt, renew, and reconfigure their capabilities and competences as a major source of performance (Teece et al. 1997). Dynamic capabilities are 'the organisational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die' (Eisenhardt & Martin 2000, p.1105). While the RBV emphasises the appropriate selection of resources, DCT emphasises the evolution of resources (Teece et al. 1997), as signified by two processes: resource-picking and capability-building in the organisation learning loop. Dynamic capabilities are commonly associated with a dynamic environment where an organisation needs to keep changing its resources to suit the organisation's strategy under a particular circumstance (O'Connor 2008). Hence, from the DCT perspective, organisational resources need to be adaptive, renewable, and reconfigurable to provide sustainable competitive advantage (Teece et al. 1997). Under different business environment conditions, different types of dynamic capabilities are needed. Therefore, dynamic capabilities have to be adapted to the various business contexts that organisations fall into. Further, in order to sustain competitive advantage, dynamic capabilities should be renewable and reconfigurable. The DCT-based view provides a relevant theoretical lens to conceptualise the link between ES and OA.

ES can represent valuable and arguably rare resources. They provide an essential business platform; can be key sources of organisational capabilities; and can potentially, albeit indirectly, contribute to OA (Sambamurthy et al. 2003). However, ES resources are not static or ultimately superior in enabling OA. Instead, ES resources need to be carefully selected, configured, and combined with other non-ES organisational resources to generate two critical dynamic capabilities—sensing and responding.

Using the PBV, a number of studies have developed models around the definition of OA as the ability of an organisation to sense environmental changes and respond effectively to these changes. Two key processes are identified in pursuing agility. These are the process of sensing changes in the internal and external environment and the process of responding to changes effectively and in a timely and cost-efficient manner (Seo & Paz 2008). Sensing and responding are two core antecedents of OA. Sensing and responding are viewed as the two core processes that work in sequence to identify and handle changes to obtain OA (Seo & Paz 2008). Therefore, from the dynamic capability view, sensing capability and responding capability are the two capabilities that generate higher order OA.

Sensing capability refers to an organisational ability to quickly detect, interpret, and capture organisational opportunities (Oosterhout et al. 2006; Seo & Paz 2008). Proactively sensing by systematically scanning the environment (i.e., searching for early indications of new ideas or trends, forecasting market movements) enables organisations to adjust to changes quickly (Tan & Sia 2006). Responding capability represents an organisational ability to quickly mobilise and transform resources to react to the opportunities that the organisation senses (Gattiker et al. 2005; Oosterhout et al. 2006). In the IS field, IT/IS has been found to strongly facilitate the sensing and responding processes through the creation of a digital option, thus enabling OA (Haeckel 1999; Overby et al. 2006; Sambamurthy et al. 2003).

Sensing and responding capabilities are inter-related. If organisations are unable to sense effectively, opportunities will be missed, responses will be ineffective, and resources will be wasted. Therefore, there should be alignment between sensing and responding capabilities to effectively capture business opportunities (Overby et al. 2006). Sensing and responding capabilities, therefore, can be considered as types of dynamic capabilities that can be further enhanced through ES (Sambamurthy et al. 2003). The extent to which an organisation leverages its valuable ES competencies to enable its sensing and responding capabilities can significantly influence its level of agility. ES competencies and ES-enabled sensing and responding capabilities can together assist organisations to quickly and effectively adapt to changes, renew and reconfigure their capabilities, and become and remain agile. Figure 3.1 captures the structure of the conceptual framework.

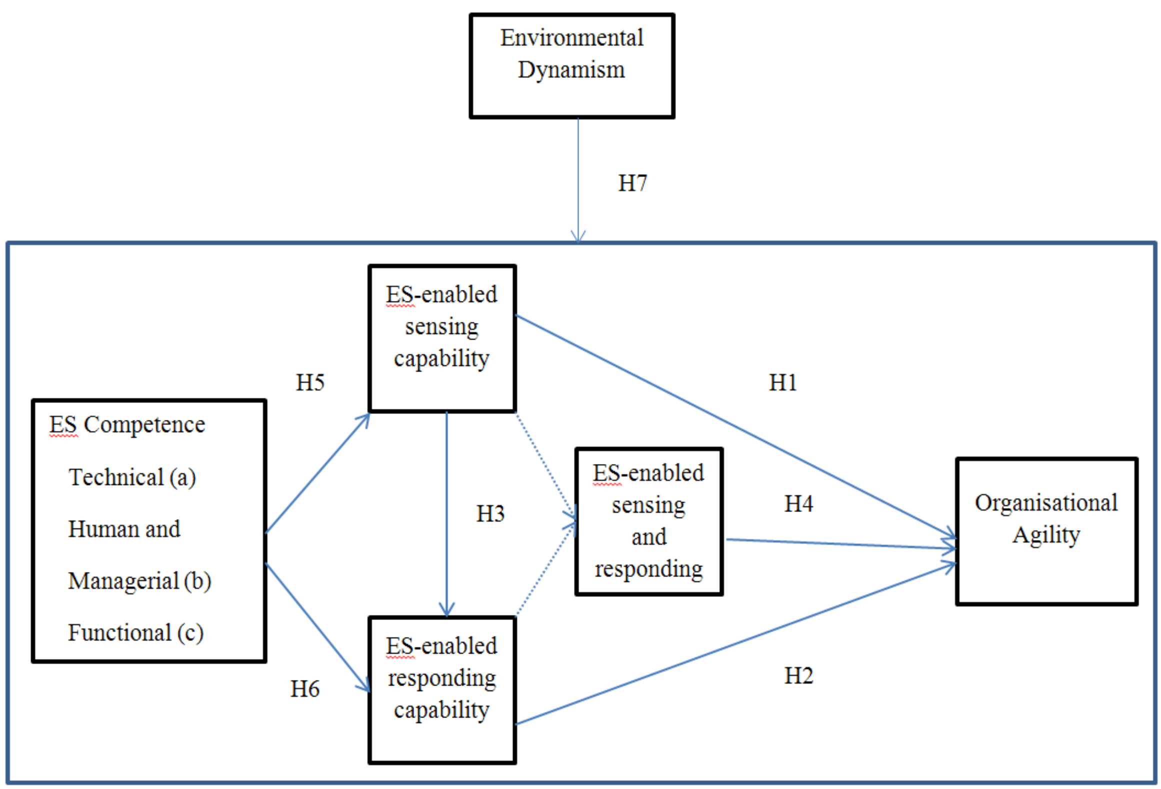


Figure 3.1: A Conceptual Framework Linking Enterprise Systems to Organisational Agility

3.3 ORGANISATIONAL AGILITY

OA is viewed in this study as both a quality of organisational performance and the high-level dynamic capability that an organisation excels in. The frequency of concepts appearing in various definitions of OA indicate that the nomological net of achieving OA comprises the sensing capability, the responding capability, speed, and impact of the ED dimensions. The two concepts—sensing and responding—demonstrate the fundamental process that every organisation performs when confronted with changes. Hence, fundamentally, enterprise agility has two core enabling elements: (1) sensing capability, which refers to an accurate and timely awareness of changes, and (2) responding capability, which refers to an ability to change business processes and to customise operational responses in real time (Dove 2005). Thus, OA can be defined as follows:

> *OA is the performance of an organisation to excel in utilising its resources in order to quickly sense changes from its business environment and respond to those changes appropriately.*

3.4 ENTERPRISE SYSTEM-ENABLED SENSING CAPABILITY

To conceptually ground the notion of ESS, this study draws from the strategic management literature. Here, sensing capability is closely related to the market orientation and absorption capability (Cohen & Levinthal 1990; Kohli et al. 1993; Overby et al. 2006). Market orientation refers to a firm's ability to generate and use market intelligence about current and future customer needs (Kohli et al. 1993). Absorptive capacity refers to the ability to acquire, assimilate, transform, and apply knowledge (Cohen & Levinthal 1990). Thus, sensing capability covers both market orientation and absorptive capability (Overby et al. 2006). Sensing capability not only indicates the ability of an organisation to sense current changes, but also to develop market foresight to anticipate changes in the future. Organisations that are able to anticipate changes in their business environment can quickly devise their responding actions ahead of their competitors.

There are various ways of building sensing capability. Neill, McKee and Rose (2007) argued that organisations that possess a better capability to communicate relevant information between members of the decision-making team interpret their environment in a multidimensional way and analyse the information simultaneously by incorporating multiple perspectives will have a greater sensing capability and eventually become more agile. Furthermore, anticipatory capability, which refers to the ability to predict the way that the market is moving, can be an essential dimension of sensing capabilities (Day 1994). Overall, the development of sensing capability requires organisations to scan the business environment and capture business insights beyond the usual sources. Such capability can be developed by organisational technologies, processes, values, and norms that together generate knowledge about future condition (Sambamurthy et al. 2003).

Based on the above logic, it is postulated that ES, as valuable resources, can be deployed as one source of capability building mechanisms to either directly or indirectly enable sensing capability. In this study, this construct is named ESS capability and is defined as follows:

ESS is the ability of an organisation to quickly and efficiently use its ES to digitise the process of sensing and develop strategic market foresight about its business environment.

The sensing process includes capturing, interpreting, and analysing change signals from the business environment. ES functionalities can digitise the sensing process. Table 3.1 presents the concept matrix of ESS capability, and is followed by a discussion of the construct.

Table 3.1Concept Matrix: Enterprise System-enabled Sensing Capability

Domain	Citation	Method	ESS Capability		
			Capturing	Interpretin	Analysing
ES	Seethamraju 2009	Case study	X		X
	Coltman 2007	Survey	X	X	X
	Dong & Zhu 2008	Survey	X	X	X
IS	Goodhue et al. 2009	Case study	X	X	X
	Huang & Nof 1999	Case study	X		X
	Dove 2005	Conceptual	X		
	Setia et al. 2008	Case study		X	X
	Overby et al. 2006	Conceptual	X	X	X
	Sambamurthy et al. 2003	Conceptual	X	X	X
	Izza et al. 2008	Conceptual	X	X	X
	Gallagher & Worrell 2008	Conceptual	X	X	
	Lee et al. 2009	Survey	X	X	X

ES, when implemented correctly, offer organisations many advantages, such as standardising procedures across global divisions, consolidating detailed transaction data from different functions and methods to access data throughout the entire range of organisational activities (David et al. 2003). Therefore, ES enables organisational sensing capabilities by extending the richness and range of information available to the organisation, hence creating OA (Sambamurthy et al. 2003). ES offer global connectivity of activities, data, and processes. This connectivity makes it easier to integrate information internally across departments and externally with business partners (Gattiker et al. 2005). Internal and external integration allows organisations to sense opportunities and problems in various areas such as changes in customer demand or partnering relationships (White et al. 2005). ES store data centrally and allow the use of powerful data analysis tools, such as business intelligence, to quickly see hidden trends in data and to disseminate the information across an organisation.

Although Newell et al. (2007) postulate that ES alone increases organisational efficiency while reducing OA, their research also suggests that, in cases where ES is complemented with the concurrent implementation of flexibility-focused initiatives (e.g., knowledge management system), ES can improve both organisational efficiency and innovation capability simultaneously. This allows organisations to make better decisions (Dong & Zhu 2008). Sensing processes incur costs. Therefore, only significant changes that can create considerable impacts with a moderate level of severity should be treated. Organisations that can quickly classify changes will have a more efficient sensing mechanism. When organisations use ES with built-in key performance indicators and benchmarks, they will be able to quickly filter for potential changes that have significant magnitude. This allows them to sense changes in real time while lowering operating costs and increasing agility (Oosterhout et al. 2006). For example, Coltman (2007) suggests that the customer analytic functionality of CRM can enable organisations to develop proactive rather than reactive market sensing.

ES provide digital options by digitising knowledge and business processes (Sambamurthy et al. 2003). Digitised knowledge with sufficient reach and richness can significantly impact a firm’s sensing capability and, through that, its agility. Digitised knowledge reach is defined as the comprehensiveness and accessibility of codified knowledge in a firm’s knowledge base and the interconnected networks and systems for enhancing interactions among individuals for knowledge transfer and sharing (Sambamurthy et al. 2003). Digitised knowledge richness is defined as systems of interactions among organisational members to support sense-making, perspective sharing, and development of tacit knowledge (Sambamurthy et al. 2003). While digitised knowledge represents ES-enabled strategy execution ability, the strategy generation for business environment sensing is facilitated by market (business environmental) foresight and organisational learning ability. The above leads to:

Hypothesis 1: *Organisations that use ES (such as ERP, CRM and SCM) in building and renewing their sensing capabilities are more likely to become highly agile*.

3.5 ENTERPRISE SYSTEM-ENABLED RESPONDING CAPABILITY

Response capability is an essential and distinguishing feature of an agile organisation (Christopher et al. 2004; Dove 2001, 2005). Responsiveness, along with knowledge management and value proposition, are the cornerstones of agility (Dove 2005). While sensing capability generates knowledge of the business environment, responding capability transforms that knowledge into action effectively (Gattiker et al. 2005; Haeckel 1999). Responding capability is thus reflected by the change-enabling capabilities that are embedded in organisational processes (Li et al. 2008). Christopher et al. (2004) suggest that short time-to-market, the ability to scale up (or down) quickly, and the rapid incorporation of consumer preferences into the design process are typical characteristics of responsiveness. Response acts are the result of a range of operating and strategy capabilities that organisations develop. Overby et al. (2006) suggest four fundamental responding capabilities: (1) production development capabilities to facilitate a firm's ability to embark on new ventures; (2) systems development capabilities to quickly and efficiently implement change to existing systems such as reusable service, SOA; (3) supply-chain and production capabilities to adjust existing ventures by shifting production to match a pending change in demand, such as high supply chain visibility; and (4) flexible resource utilisation to shift resources to areas of need to embark on new ventures or adjust existing ventures. Based on the above understanding of responding capability, this study postulates that ES, as valuable resources, can be deployed as a source of responding capability building mechanisms. This construct is named ESR capability and is defined as follows, with Table 3.2 summarising the concept matrix:

ESR is the organisation's ability to deploy its ES resources and embed them in its production development, systems development, supply chain and production, and flexible resource utilisation strategies and processes to quickly and efficiently respond to changes.

Table 3.2: Concept Matrix: Enterprise System-enabled Responding Capability

Domain	Citation	Method	ESR Capability			
			Product development	System development	Supply chain and production	Flexible resource utilisation
ES	Goodhue et al. 2009	Case study	X	X	X	
	Seethamraju 2009	Case study	X	X	X	X
IS	Dove 2005	Conceptual	X	X	X	X
	Tan et al. 2009	Case study	X	X	X	X
	Overby et al. 2006	Conceptual	X	X	X	X
	Sambamurthy et al. 2005	Conceptual	X	X	X	X
	Izza et al. 2008	Conceptual	X	X	X	X
	Gallagher & Worrell 2008	Conceptual	X	X		X
	Lee et al. 2009	Survey	X	X	X	
	Seo & Paz 2008	Conceptual	X	X	X	X

Organisations can exploit their various ES to excel in their responding capabilities. Ravinchandran and Lertwongsatien (2005) suggest that organisations can employ ES to access markets, re-engineer business processes, and develop new products or services. ES provide background information that can be used to design competitive response initiatives (Mondragon et al. 2004). ES also provide shared values between different business units (sales, manufacturing, human resources, etc.) inside organisations and across their business partners. Shared values enable collaboration in designing or implementing changes (Seethamraju & Seethamraju 2009). Standardisation and integration, which are the fundamental outcome of ES, create simplicity and facilitate faster decision making and action and, thus, enable response capability (Gattiker et al. 2005).

Organisations that have used ES can leverage the digital business ecosystem to advance agility (Tan et al. 2009). Information is shared across the ecosystem regardless of geographical or time constraints, which can reduce response time. Information and business process integration within the organisation's ecosystem enable an organisation to have better visibility regarding the operations of its business partners, as well as strengthen the relationship within the whole supply chain, thus enabling organisation responsiveness. Furthermore, the availability of ES built-in flexibility provided by ES vendors, such as WS and SOA, determines OA (Gattiker et al. 2005). Further, organisations can increase their digital process reach and richness through ES. Digitised process richness refers to the quality of information collected about transactions in the process, the transparency of that information to other processes and systems that are linked to it, and the ability to use that information to reengineer the process (Sambamurthy et al. 2003). Digitised process reach refers to the extent to which a firm deploys common, integrated and connected IT-enabled processes. The capability of ES to provide digitised process reach and richness enables organisational response capability as it facilitates organisations' ability to quickly and easily (re)configure and mobilise organisational resources/capabilities. Sambamurthy et al. (2003) provide the example of eBay's online auction which relies on its ES to integrate its sales processes with a variety of partner processes, including payment and shipping processes. The extent to which organisations exploit ES to underpin their strategies can result in significant variations in ESR and in OA. This leads to the following proposition:

> ***Hypothesis 2:*** *Organisations that use ES (such as ERP, CRM and SCM) in building and renewing their responding capabilities are more likely to become highly agile.*

Furthermore, the relationship between sensing capability, responding capability, and OA can be viewed from a PBV perspective. From the PBV, OA is 'a set of processes that allows an organisation to sense changes in the business environment, respond efficiently and effectively in a timely and cost-effective manner and learn from the experience to improve the competencies of the organisation' (Seo & Paz 2008, p. 136)). None of these steps can be omitted from the process. Teece and colleagues (1997) also found that organisations that more frequently engage in market sensing and more frequently seize opportunities and reconfigure their resource base will be more capable of dealing with market turbulence and better prepared to align their resource base with the environment than organisations with less practice in these areas. Although variation in sensing and responding capability can create different types of agility levels, high sensing capabilities will generally lead to high responding capabilities, allowing firms to rapidly retool existing products, change production volumes, and customise service offerings. Thus:

> ***Hypothesis 3:*** *Higher ESS capability is more likely to lead to higher ESR capability.*

3.6 ENTERPRISE SYSTEM-ENABLED SENSING AND RESPONDING CAPABILITY ALIGNMENT

Changes identified through the sensing process require an appropriate response. The alignment between sensing capability and responding capability ensures that no changes are ignored and organisational resources are not wasted, thus obtaining the optimal effect on OA and, ultimately, organisational performance (Haeckel 1999; Overby et al. 2006; Teece et al. 1997). The strategic fit between sensing and responding capabilities has been discussed in the literature under various constructs. Dove (2005) suggests value propositioning skills, along with knowledge management and responding capabilities, as the three cornerstones of the agility. Value propositioning refers to effective prioritisation and choice making among competing response alternatives. Thus, value propositioning skills align the requirement for responding to the opportunities that an organisation can sense and the actual responding capabilities of the organisation. Sambamurthy et al. (2003) postulate that entrepreneurial alertness, which consists of strategic foresight and systemic insight, is essential for converting digital options into agility. Entrepreneurial alertness refers to the mechanism that aligns the need for promoting agility (sensing capability) and digital options (responding capability). Both value propositioning skills and entrepreneurial alertness refer to the alignment of sensing and responding capabilities.

The alignment between sensing and responding capabilities can be taken from three perspectives: moderating, matching, and mediating (Bhatt et al. 2010). Based on the moderating perspective, the impact of responding capabilities on OA varies according to different levels of sensing capabilities. By sensing more opportunities or threats (greater sensing capabilities), organisations will have a greater chance of taking more action in responding to these changes. However, the moderating view is valid only if organisations are proactively learning over a period of time. From the mediating perspective, OA is dependent on the ability of the organisation to respond to only the changes that it is able to capture. Lewis et al. (2008), through cross-case analysis of IT strategies at two companies, Zara and Li & Fung, that are famous for being highly agile in volatile businesses such as the apparel industry, suggest that organisations need to design a decision rights architecture with the ability to respond and act on available information to achieve a high level of agility. From the matching view, development of sensing capabilities and responding capabilities is separate (Overby et al. 2006). The match between sensing and responding capabilities will lead to various states of alignment of sensing and responding (i.e., high sensing/high responding, high sensing/low responding, low sensing/high responding and low sensing/low responding). The stronger the alignment between sensing and responding capabilities, the better the performance of an organisation's agility. However, if this alignment is low, a high level of sensing capability is wasted if the organisation cannot respond, while high levels of responding will not improve OA due to not being able to detect opportunities. Thus:

> ***Hypothesis 4:*** *Better alignment of ESS and ESR capability is more likely to lead to higher OA.*

3.7 ENTERPRISE SYSTEM COMPETENCE

The creation of ES-enabled sensing and responding capabilities depends on the quality of the ES infrastructure an organisation has put in place. ES are not simple IT solutions but include the dextrous combination of human- and business-related competencies (Coltman 2007). ESC refers to the quality of the ES infrastructure. For the purpose of this research, the focus will be on the ESC developed after the adoption and during the continuance of ES use (Lim et al. 2005). As ES are regarded as the most prominent development of IS, the IS competences literature will be to drawn on to define ESC. A review of the literature has resulted in the identification of three fundamental dimensions of IS competences: *technical infrastructure competence, human and managerial competences and functional competence* (Bhatt et al. 2010; Piccoli & Ives 2005; Tallon 2008; Wade & Hulland 2004). These dimensions are summarised in Table 3.3.

Table 3.3 Dimensions of Enterprise System Competencies

IS Competence	Subcategory	Description	Citations
Technical Competence	Hardware compatibilities	Systems interoperability and integration, seamless access via common user interface.	Byrd & Turner 2000; Piccoli & Ives 2005; Stratman & Roth 2002; Tallon 2008; Wade & Hulland 2004; Weill et al. 2002
	Software modularity	Rapid software development, reusable code, software portability across systems, ability.	
	Network connectivity	Ability to expand or contract network reach, remote access to shared data pools, adaptable links to internal and external parties.	
Human and Managerial Competences	Technical knowledge and skills	The technical ability of IS personnel based on their specific expertise in technical areas.	Bharadwaj 2000; Bhatt & Grover 2005; Byrd & Turner 2000; Fink & Neumann 2007; Piccoli & Ives 2005; Ravichandran 2007; Stratman & Roth 2002; Tallon 2008; Weill et al. 2002
	Behavioural knowledge and skills	The interpersonal and management ability of ES personnel to interact with and manage others.	
	Business knowledge and skills	The ability of IS personnel to understand the overall business environment and the specific organisational context.	
Functional Competence		The range of business functions that are supported by IS.	Karimi et al. 2007 Karimi et al. 2009

Since ES is a specific type of information systems, the general IS competences coupled with the unique characteristics of ES such as integrating data and business processes, standardisation of providing solutions to business problems, building on modularised structure, and allowing customisation for specific business processes define the domain of ESC (Devadoss & Pan 2007; Lorincz 2007). Therefore, extending from the literature of IS competences which have been summarized in table 3.3, and based on other research on ES capabilities (Devadoss & Pan 2007; Dong & Zhu 2008; Maurer 2009; Stratman & Roth 2002), we identify three dimensions of ESC—*ES technical infrastructure competence*

(EST), *ES human and managerial competence (ESHM)* and *ES functional competence (ESF)* (see Table 3.4 for the concept matrix).

Table 3.4: Concept Matrix of Enterprise System Competence

Citation	Method	ESC		
		Technical	Human and Managerial	Functional
Daghfous 2007	Conceptual	X	X	
Dong & Zhu 2008	Survey	X		
Devadoss & Pan 2007	Case study	X		
Fink & Neumann 2007	Survey		X	
Fink & Neumann 2009	Survey		X	
Goodhue et al. 2009	Case study	X	X	
Grant & Chen 2005	Survey	X	X	
Karimi et al. 2007	Survey	X	X	X
Karimi et al. 2009	Survey	X	X	X
Lim et al. 2005	Case study		X	
Maurer 2009	Conceptual	X	X	
Sprott 2000	Conceptual	X		
Stratman & Roth 2002	Survey		X	

ES technical infrastructure competence is defined as the ability of ES technical infrastructure to deliver and support rapid design, development and implementation of ES, and the ability to distribute any type of information across organisations. Two essential qualities of ES technical infrastructure are integration and adaptability (Sprott 2000; Stratman & Roth 2002). Integration refers to the establishment of a collaborative platform, which allows a free-flow of information internally within the organisation and externally with the IS of business partners (Seethamraju 2009; Swafford et al. 2008). The adaptability of ES indicates the extent to which the ES can be easily (re)configurable or restructured in accordance with new conditions. IS flexibility is assessed based on two strategies: (1) the flexibility-to-use, which refers to the features that IS supports without major modification to the IS, and (2) flexibility-to-change, which refers to the process requirements supported by IS through adjustments and modifications of the IS (Gebauer & Schober 2006). Therefore, the adaptability of ES requires both a high level of reach and richness of ES functionalities that support both the business operation and the reconfigurability of the ES. The technological ESC enables system interoperability with other ES, which may be developed by other ES vendors, or special-purpose add-on systems provided by third-party vendors (Goodhue et al. 2009).

High ES technical infrastructure competence enables a free flow of information within an organisation and between the organisation with its business partners in the supply chain, thus supporting a quick capture and analysis of information to identify changes more efficiently. Moreover, ES technical infrastructure competence indicates a highly flexible ES infrastructure that allows add-ons and reconfiguration of the ES system when needed; hence, it enables responsive capability.

ES human and managerial competence refers to the technical and managerial knowledge and skill of using an enterprise's ES in performing business processes (Dong & Zhu 2008; Stratman & Roth 2002). This includes technical, business, and behavioural skills (Fink & Neumann 2007). Technical skills refer to IT staff and end users ability to configure, maintain, and effectively use ES (Stratman & Roth 2002). Business skills refers to the management skills and business process knowledge possessed by individuals working on ES (Lim et al. 2005; Maurer 2009; Stratman & Roth 2002). Behavioural skills refer to the interpersonal skills of the people involved in ES, such as the ability to work cooperatively in cross-functional teams with personnel from other departments (Fink & Neumann 2007). Organisations should not only develop these skills generally but also focus on the ES-specific absorptive capacity (Daghfous 2007). For example, CRM-specific absorptive capacity allows the firm to acquire, assimilate, analyse and leverage customer-specific knowledge to produce an array of tailored innovative products and services that meet the ever-changing customer needs (Daghfous 2007, p. 61).

ES human competence enables the sensing capabilities of organisations in terms of higher knowledge transfer across different business areas in an organisation, thus allowing the information to be quickly captured and analysed. In addition, rich knowledge on ES capabilities allows a quick recall of business processes that can be supported by the ES, thus enabling a higher responding capability. ESM refers to management's project management, change readiness, and strategic planning acumen (Stratman & Roth 2002). Since ES are mostly provided by vendors such as SAP and Oracle, the procurement skills—the ability to learn, develop, and work with external suppliers for appropriate ES deployment—is crucial in managing ES (Maurer 2009). Changing business environments require changes in business processes and technology that support business processes. Hence, organisations need to frequently evaluate the performance of their ES, allocate resources for upgrade and maintenance, and align ES development with the overall IS and organisational strategies. With high ESM, organisations can maintain the system to provide up-to-date to support with any modification in organisational business processes, thus enabling sensing and responding capabilities. Thus, ESF refers to the extent of ES implementation and the quality of using ES in supporting business functions (Karimi et al. 2009).

The extent of ES implementation indicates the type of benefits that can be derived from ES systems and specifies the degree to which ES will change process integration in the business units of the organisation (Markus et al. 2000). ES implementation is divisible to the extent that it can be divided up into sequential or incremental implementation by functions, department, the entire company, multiple companies, locations or regions (Karimi et al. 2009). ES divisibility allows managers the flexibility to change the scope of the implementation. *The extent of ES implementation* is defined as ES functional scope, which refers to the range of business functions that are supported by ES. Greater ES functional scope is achieved through the implementation of ES. Wider functional scope allows greater data and process integration across different business areas in an organisation or with their partners. Hence, greater ES functional scope allows data to be sensed on a wider scale. Furthermore, it supports cooperation in responding to changes through better mobilisation of organisational resources. ES functional scope represents ESC that facilitates both the sensing and the responding capabilities of organisations. However, regardless of how powerful the ES is in supporting business processes, an ES will bring no benefits to organisations if the users do not use it. (Tippins & Sohi 2003) define IT competency to consist of the extent to which the firm uses IT. Hence, another dimension for ESF is the extent to which ES is used in supporting business processes.

Overall, ESC allow organisations to integrate a wider range of systems internally and externally and to capture data from various sources. Furthermore, the ability to distribute any type of data across an organisation enables data to be interpreted from various perspectives. Capturing data from various sources and interpreting them with various perspectives enables organisations to detect and capture changes quickly and respond to them efficiently (Dove 2005; Maurer 2009). Hence:

> ***Hypothesis 5:*** *Organisations that have developed a high level of ESC are more likely to exploit that competence in order to build their ESS capability.*

> ***Hypothesis 6:*** *Organisations that have developed a high level of ESC are more likely to exploit that competence in order to build their ESR capability.*

Since ESC is theorised to consist of three components: ES technical competence, ES human and managerial competence, and ESF, Hypothesis 5 and Hypothesis 6 can be restructured as:

> ***Hypothesis 5a:*** *Organisations that have developed a high level of ES technical competence are more likely to exploit that competence in order to build their ESS capability.*

> ***Hypothesis 5b:*** *Organisations that have developed a high level of ES human and managerial competence are more likely to exploit that competence in order to build their ESS capability.*

> ***Hypothesis 5c:*** *Organisations that have developed a high level of ES functional competence are more likely to exploit that competence in order to build their ESS capability.*

> ***Hypothesis 6a:*** *Organisations that have developed a high level of ES technical competence are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6b: *Organisations that have developed a high level of ES human and managerial competence are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6c: *Organisations that have developed a high level of ES functional competence are more likely to exploit that competence in order to build their ESR capability.*

3.8 ENVIRONMENTAL DYNAMISM

The proposed framework has one boundary condition, that is, the impact of ED factors such as competitiveness and the complexity of the environment (Sambamurthy et al. 2003). These dynamism factors can influence the level of agility required in an organisation (i.e., organisations operating in stable industries with predictable changes will require different levels of agility to those who operate in a rapidly changing environment) (Tallon 2008). The impact of market-sensing activities on organisational performance vary with the degree of market turbulence (Eisenhardt & Martin 2000), while ED also significantly requires faster strategic decision-making speed and thus greater responsive capabilities (Baum & Wally 2003). Organisations operating in turbulent environments face higher uncertainty and therefore need to process information more rapidly than organisations that operate in more stable business surroundings (Tallon 2008). ES centrally manages information flows within an organisation and across the organisation and its business partners. Therefore, the extent of ED can be proposed to serve as a control variable on how ES can be used to achieve agility:

Hypothesis 7: *Organisations that operate in rapidly changing environments where product shelf life is short are more likely to develop high OA, ESC and ES-enabled sensing and responding capability than those that operate in a relatively stable environment.*

Hypothesis 7 can further constructed as:

Hypothesis 7a: *ED positively moderates the relationship between ESS capability and OA.*

Hypothesis 7b: *ED positively moderates the relationship between ESR capability and OA.*

Hypothesis 7c: *ED positively moderates the ESS capability support for ESR capability.*

Hypothesis 7d: *ED positively moderates ESC support for*

ESS capability.

Hypothesis 7e: *ED positively moderates ESC support for ESR capability*

Hypothesis 7f: *ED positively moderates the OA level.*

Hypothesis 7g: *ED positively moderates ESS capability.*

Hypothesis 7h: *ED positively moderates ESR capability.*

Hypothesis 7i: *ED positively moderates ESC.*

3.9 CHAPTER SUMMARY

The purpose of this chapter was to introduce a theoretical framework for investigating the mechanism by which ES enables OA. This framework aims to answer the research question that was proposed to address the research gaps indentified in the literature review presented in Chapter 2. This framework suggests several hypotheses between the different constructs. Chapter 4 will discuss the research methodology used to empirically examine the proposed theoretical framework and test the research hypotheses.

CHAPTER 4: METHODOLOGY

4.1 INTRODUCTION

Chapter 3 presented the theoretical framework of this research study. In this chapter, the research design is introduced. It briefly describes the research philosophy, research method, data collection and analysis plan as well as the research schedule for examining the constructs and their hypothesised relationships that structure the proposed model. The three questions central to the design of research are: (a) what knowledge claims are being made (including a theoretical perspective such as positivism, interpretivism, etc)?; (b) what strategy of inquiry will inform the procedures?; and (c) what methods of data collection and analysis will be used? This chapter will discuss the issues that need to be addressed through these three questions.

In Section 4.2, the research philosophy is discussed to anchor the philosophical standing as well as the fundamental beliefs that direct and give the rationale for the research method used in this study. Next, the discussion further focuses on the research methodology employed, presented in Section 4.3. Section 4.4 explains the instrument design, and specifies the definition as well as the measurement items of the constructs proposed in the model as well as where the items are derived from. The discussion continues with the sample design, presented in Section 4.5, which describes the setup of the targeted sample frame and the sample size. Section 4.6 provides detail on the data collection method that was used. Specifically, the administration of the survey is presented in detail. Section 4.7 specifies the ethical issues related to the conduct of the research. The chapter concludes with Section 4.8, a brief summary and discussion of the chapter.

4.2 RESEARCH PHILOSOPHY

The question of the philosophical standing of a researcher needs to be established before a researcher undertakes detailed study. This is because philosophy refers to the critical examination of the grounds for fundamental beliefs and an analysis of the basic concepts employed in the expression of such beliefs (Dobson 2002). Research philosophy guides how a research is conducted (Khazanchi & Munkvold 2003). The three characteristics of a research philosophy, which together frame the nature of the research and the role of the research in the scientific inquiry, are reality (ontology), knowledge of that reality (epistemology) and the particular ways of knowing that reality (methodology) (Creswell 2009; Guba, 1990; Khazanchi & Munkvold 2003; Hirschheim &Klein 1991; Walsham 1995).

Ontology is the theory of 'reality' that researchers investigate (Creswell 2009; Healy & Perry 2000). Ontology is the question of the existence of a real world: whether it stands independently of human thoughts and speech, or it is a construct dependent on human consciousness (Becker & Niehaves 2007). Epistemology is the theory of knowledge and how it can be obtained—how we know what we know and how we have knowledge of the world around us (Khazanchi & Munkvold 2003). Epistemology is the relationship between reality and researchers. Methodology is the theory of how researchers establish if what they believe can be known (Guba & Lincoln 1994).

Research paradigms are classified into three categories: positivism, interpretivism and critical realism (Orlikowski & Baroudi 1991). Positivism and interpretivism are often mentioned as the dominant philosophy of IS research (Er 1989; Mingers 2001; Orlikowski & Baroudi 1991) and influence a researcher's ontological, epistemological and methodological standing. The following sections will discuss each of these three dimensions in details.

4.2.1 Ontology

Ontological assumptions are concerned with the nature of the world, or, in other words, reality. Within ontology, there are two propositions: realism and nominalism (Er 1989). Positivism—following ontological realism—is often referred to as naïve realism and postulates that the world is comprised of objectively given, immutable objects and structures (Goles & Hirschheim 2000). Therefore, the main principle of positivism is the view that the world is structured and all parts of the world are subject to uniform and determined relationships. There is only one world (reality), and it exists independently from human experiences (Chen & Hirschheim 2004). In addition, that world is comprehensible though empirical observations.

However, this positivist view has been strongly criticised by interpretivists as representing observational objects and not covering the whole picture of reality but a part of a pre-given linguistic structure from observers (Mingers 2008). In contrast, interpretivists—following nominalism—emphasise the subjective meaning of reality that is created through human and social interaction processs (Burrell & Morgan 1979; Chen & Hirschheim 2004). From the interpretivist perspective, different individuals construe different realities, hence, there are multiple realities or multiple truths based on one's comprehension of reality. Further, socially transmitted concepts direct how reality is perceived and constructed, so reality is constantly changing (Goles & Hirschheim 2000; Sale et al. 2002). What used to be considered as truth in the past might not be valid in the present in the context of social transformations. Therefore, reality has no existence prior to the activity of investigation, and reality ceases to exist when we no longer focus on it (Sale et al. 2002).

Ontologically, critical realism strongly supports ontological realism, which claims that reality is comprised of objectively given, unchangeable objects and structures. Agreeing with the positivist, the realist asserts that the world would exist whether or not humans exist. However, while positivism suggests that reality is apprehensible, critical realism claims that reality can be only imperfectly and partially apprehensible (Guba & Lincoln 2005, p. 193). Critical realists advocate the concept of multilayering reality, with a lower level—the empirical—which consists of experiences and sense impression (events which can be observed will generate experiences, thus not all events can be experienced); the actual, which consists of events; and the real, which consists of the entities and structures that produce events. Instead of referring to only the solid world or reality in the general context, critical realism acknowledges the existence of various worlds. Cupchik (2001) mentions the social world, which is 'reflect through reflected in the natural attitude of daily life and exists prior to and independent of either positivist or constructivist analysis'.

Similarly, Bhaskar (1979) recognises the existence of two worlds, an intransitive world that is natural and relatively unchanging and a transitive world that is social and historical. Beginning from Habermas' (1978, 1984) theory of communicative action observation, other critical realists classify reality into three worlds: material, social and personal. According to Mingers (2001) and Cupchik (2001), 'each world has different modes of existence and different epistemological possibilities'. Although the material world exists independently of humans, we are able to characterise it through observation processes. However, such observations are always theory- and subject-dependent because they depend on the observer as well as the description of the observed. The social world, as defined by Mingers (2001), consists of 'complex language, meaning, social practices, rules and resources that both enables and constrains our actions'. Although humans construct and participate in the social world, our relationship with it is inter-related because it goes beyond and pre-exists any particular individual. The personal world is the world of our own individual thoughts, emotions, experiences, and beliefs (Mingers 2001). We do not observe it, but experience it. This world is subjective, in that it is generated by, and only accessible to, the individual subject.

4.2.2 Epistemology

Epistemology refers theories of knowledge and characterised by two main points: (1) what is the nature of knowledge? and (2) how do we obtain valid knowledge? (Hirschheim 1985; Khazanchi & Munkvold 2003; Mingers 2008). In terms of epistemology, positivists believe that only observable things are real and worthy of study, thus verified knowledge must be derived by means of sensory experience (Khazanchi & Munkvold 2003). Positivism is concerned with the hypothetic-deductive testability of theories, whereby it is assumed that the objective data collected by the researcher can be used to test prior hypotheses or theories (Walsham 1995). Moreover, as there is only one reality which is unchanged regardless of time or place, knowledge about reality should also be immutable. With the same set of causes, we will always observe the same set of results. Therefore, in positivism, causal relationships are usually presented as a tight coupling between explanation, prediction and control is expected. Scientific knowledge should allow verification of falsification and seek generalisable results, known as universal laws. However, positivism has been criticised for the fact that it undervalues the importance of logical analysis and conceptual judgement to support the immediate empirical observations (Duran 2005).

In contrast, interpretivists assume that scientific knowledge should be obtained not through hypothetic-deductive logic, but through the understanding of the human and social interactions by which the subjective meaning of the reality is constructed (Chen & Hirschheim 2004; Walsham 1995). If an entity does not contain any value or benefit for our perceptions we are unconscious of the existence of that entity. Hence, knowledge about that particular entity will not be created. While in positivism knowledge is labelled as valid if the results of observational research correspond to how things 'really are' in the world, in interpretivism, valid knowledge is confirmed by that with which one agrees (Sale et al. 2002). Interpretivists believe that objective observation is not possible as the observational descriptive contains the intention of the observer (Duran 2005). Hence, human experience is considered to be a process of interpretation of meanings and actions, reality is relative to the observer, and these concepts need to be understood and interpreted to create specific knowledge about the social world (Khazanchi & Munkvold 2003).

Critical realism opposes both positivist and interpretist philosophy. Different from interpretivism, critical realism asserts that the conditions for knowledge do not arise in human minds but in the structure of reality, and that such knowledge will not be universal (Mingers 2004a). However, critical realists also acknowledge that observation of reality is a value-laden process operating in two different dimensions, one intransitive and relatively enduring; the other transitive and changing (Dobson 2002). In contrast to positivism, which holds that only events which can be perceived can exist, critical realists criticise the essential positivist error, known as the epistemic fallacy, by reducing the ontological domain of existence to the epistemological domain of knowledge. The epistemic fallacy equates reality to what we observe so that statements about reality are translated into ones about human knowledge or experience of reality.

From the critical realists' view, the world is far more complex and beyond the ability of humans to perceive (Mingers 2001), and positivism confuses the real world with human sensory impressions of it and pretends that what we cannot observe does not exist or does not make any difference to the actual characteristics of the world. Critical realism supports the conclusion that the more information we can gather from reality, the more confident we can be in our knowledge about it. Inheriting the Greeks' philosophy, Hirschheim (1985) defines two types of knowledge: (1) that which was believed to be true and (2) that which was known to be true. Science is the process that transforms the former to the later. As knowledge involves the understanding of human beings, it is a matter of societal acceptance, and is regulated by an agreed set of conventions. Furthermore, because knowledge is obtained through a realisation process, it is not static, but well thought out and evolving over time and place. More data and information produced in the future may void or replace the knowledge claims of the past. Critical realism also agrees that our knowledge of reality is impacted by social conditions and thus cannot be understood independently of the social context (Dobson 2002).

4.2.3 Methodology

Researchers acknowledge that there should be a link between ontology and methodology (Dobson 2001). Therefore, through the selection of the object or the purpose of research, we can establish which research methodology will be the most suitable for that purpose. However, this is not absolute (Klein & Myers 1999; Mingers 2004b). For example, case studies can be used in both positivist and interpretivist research. Positivists contend that to test hypothetic-deductive theories, research should take a value-free position and employ objective measurements to collect research evidence (Walsham 1995). Quantitative methods enable investigators to study a phenomenon without influencing it or being influenced by it. Quantitative research can produce bias-free results though logical analysis and mathematic calculation. Therefore, quantitative methodology is normally based on positivism (Sale et al. 2002).

In contrast, interpretivists argue that to understand the meaning embedded in human and social interaction, researchers need to engage in the social setting investigated and learn how the interaction takes place from the participants' perspective. Quantitative methods allow investigators to study a phenomenon without influencing it or being influenced by it whereas in qualitative research, the investigator and the object of study are interactively linked and the emphasis of the research is on process and meanings (Guba & Lincoln 2005). Further, qualitative research can enhance the in-depth understanding of the topic being investigated. Therefore, the qualitative paradigm is based on interpretivism, while the quantitative paradigm is based on positivism (Sale et al. 2002). This study takes the positivist perspective and hence the quantitative paradigm is the most appropriate investigative approach.

Mingers (2003) lists the methods typifying positivist and interpretive research. For positivism, the methods are:

- *(Passive) observation, measurement and statistical analysis:* includes internally or externally published data and direct observation, recording or measurement. The data produced are generally quantitative.
- *Survey, questionnaire or instrument:* includes all forms of data production involving the circulation of a pre-structured set of questions.
- *Experiments*: includes both laboratory and field experiments. The classification includes any statistical analysis of the results.
- *Simulation:* involves the artificial production of data in such a way that it is representative of some aspect of a relevant real situation.
- *Case study:* a particular research situation is important in its own right, and cannot be abstracted from its context.

Methods typifying interpretive research include:

- *Interview:* real-time conversations between researcher and respondent to discover the respondent's personal views.
- *Qualitative content analysis:* analysis of texts for the occurrence of specific categories or terms. Qualitative content analysis derives its categories from the material itself in a more interpretive manner, recognising the role of the analyst in doing this.
- *Ethnography/hermeneutics:* involves the researcher immersing themselves in the language, practices, and values of a particular (sub) organisation. The aim is to be able to understand what happens through the eyes of the people involved.
- *Grounded theory:* developing theory from, or grounded in, empirical social research. The approach uses data from a range of sources in order to generate theories that plausibly explain relationships among the concepts within the data. It does not accept an independent, pre-existing reality about which truth can be discovered.

- *Participant observation:* the researcher actually becomes an active participant in the situation, usually, but not always, without the knowledge of the other people involved.

In contrast, critical realists suggest that the object of inquiry is the deep structures, mechanisms and events/effects hidden within a social situation, hence, intensive research for critical realists involves the consideration of particular contexts and combinations of isolated structures, mechanisms and actual events (Dobson 2001). Therefore, critical realism advocates mixed methods as the fundamental research methodology (Bhaskar 1979, 1989, 1994; Mingers 2001, 2003). Certain researchers claim that multi-method research is impossible due to paradigm incommensurability, whereby paradigms differ in terms of the fundamental assumptions of the process of object inquiry (Mingers 2001). Nonetheless, other critical realist researchers argue that the dominance of a single perspective results in a narrow view that does not fully reflect the multifaceted nature of social, organisational and phenomenological reality and hence the utilisation of multi-methods is feasible (Goles & Hirschheim 2000).

Mingers (2001) has provided an explanation for this argument. First, it is argued that characteristics of paradigms are not totally separate and mutually exclusive since it is not fully confirmed that research methods are wholly internal to a single paradigm. Second, the idea of paradigm incommensurability based upon objective-subjective duality is fundamentally flawed as it is not possible to separate out the objective and the subjective. Finally, different paradigms provide us with different perspectives on a reality that is more complex than the set of theories bound to any one paradigm. Practically, in order to implement multi-method research, Mingers (2001) suggests that we should combine the two important features of research situations: the multidimensionality and the activities performed at different phases of research. The result of this combining process creates different types of multi-method research designs, listed as follows:

- *Sequential:* methods are employed in sequence with results from one feeding into the next.
- *Parallel:* methods are carried out in parallel with results feeding into each other.

- *Dominant (Imperialist):* one method or methodology as the main approach with contributions from others.
- *Multi-methodology:* a combination of methods, embodying different paradigms, developed specifically for the task.
- *Multilevel:* research conducted simultaneously at different levels of an organisation and using different methods.

Table 4.1 summarises the basic characteristics of each paradigm mentioned above.

Table 4.1 *Comparing the Basic Characteristics of Research Paradigms*

Assumption	Positivism	Interpretivism	Critical realism
Ontology	The formulation of hypotheses, models, or causal relationships between constructs. Demonstrates the belief that ‘objective’ data can be collected to predict the relationship between factors and to test hypotheses or theories.	Evidence from a non-deterministic-free will perspective.	Reality can be only imperfectly and partially apprehended.
Epistemology	The use of quantitative methods, although not always necessary, to test theories or hypotheses.	Researchers’ engagement in the specific social and cultural setting investigated.	Knowledge of reality is impacted by social conditions and thus cannot be understood independently of the social context.
	Based on researchers’ objective and value-free interpretation.	Participants’ perspectives are taken as the primary sources of understanding and investigating the phenomena.	Multilayering reality; however, the observation of reality is a value-laden process.
Methodology	The foundation of science is based on logic and mathematics; hence, it is often linked to quantitative methods.	Phenomena are examined with respect to cultural or contextual circumstances. Qualitative methods are normally implemented.	Multi-methods are more suitable for this type of research.

4.2.4 The Researchers’ Philosophical Standing

A paradigm is a set of beliefs about the nature of the world and the individual’s position in it. Thus, it is a human constructions and is neither right nor wrong (Lee 1991; Shanks 2002). The selection of ontological and epistemological stance between positivism, interpretivisim or critical realism is not based on the verdict of which approach is superior.

Instead, research paradigm selection is based on the context, purpose and nature of the research study (Orlikowski & Baroudi 1991).

The positivist view has been dominantly used in IS research. A review of the research paradigms of IS research between 1983 and 1988 conducted by Orlikowski and Baroudi (1991) concluded that among the three main paradigms used in IS research positivism accounted for the dominant philosophy. Although there have been calls for enlarging the amount of non-positivist IS research (Orlikowski & Baroudi 1991), this trend continued in the following years. In examining 1,893 articles published in eight major IS journals between 1991 and 2001, Chen and Hirschheim (2004) found that the number of positivist papers account for 81 per cent of the published empirical research. Following this prevailing trend, this study is guided by positivist perspective. In addition, based on this ontological, epistemological and methodological stance, there are several rationales that justify this selection.

First, from the ontological stance, positivists assume an object reality that can be systematically and rationally investigated through empirical investigation and is driven by general causal law (Shanks 2002). This is relevant to this study, which intends to make inferences about the effect of ES on OA within the context of a dynamic environment. The theoretical model is based on perspectives and theories drawn from the ES and OA literature, the OA literature and DCT.

Secondly, described in Chapter 1, this research study aims to empirically test the hypotheses proposed to shape the relationship between ES and OA. The researcher collects information using instruments based on measures completed by respondents. Hence, the researcher remains distant and does not directly interact with or become involved in the observation or experiment, which is in this study means the researcher has no interaction with the ES or OA of the organisations being observed. The researcher merely interprets the results and has no influence on the data collected. Thus, data provides evidence that shapes the knowledge derived from the observations, but the knowledge is derived from the researcher’s thinking. This characteristic is relevant to the epistemology of positivism.

Thirdly, the essential requirement of positivist methodology is that general theories are used to generate propositions that are operationalised as hypotheses and subjected to replicable empirical testing. Hypotheses should be testable, and provide the opportunity for confirmation or falsification (Guba & Lincoln 1994; Shanks 2002). In the current study, the hypotheses are generated from formal propositions while the construct definitions and measures are based on existing constructs and are quantifiable. Further, the research follows the deductive method of reasoning for the purposes of confirming and extending previously stipulated hypotheses.

With the above rationale, it can be concluded that the current research has a positivist position with regards to ontology, epistemology and methodology.

4.3 RESEARCH METHOD

A systematic body of knowledge is developed using two principles: induction and deduction. Deductive arguments are valid if a conclusion necessarily follows from the premises. Deductive methods tend to move from the general to the specific: a deductive argument is sound if it is valid and its premises (prior statements, findings or conditions) are true (Bernard 2000). On the contrary, the inductive method begins with small group observations of similar events or subjects, detects patterns and regularities, and formulates hypotheses to develop general conclusions or theories (Bernard 2000). Deductive reasoning is different from inductive reasoning in terms of order. Deduction begins with a pre-existing theory which develops into a hypothesis. Observations are made which confirm the hypothesis. Induction occurs in the reverse order, beginning with an observation which displays a pattern. A hypothesis is formed from the pattern, and is built into a theory. Quantitative research is usually associated with deductive reasoning, while qualitative research adopts inductive reasoning (Creswell 2009). Applying deductive principles in the current study, the research begins with an abstract model. The related constructs and relationships between them are detected to develop a conceptual theoretical framework. The conceptual framework consists of hypotheses with propositions and measurement of variables. These hypotheses are then empirically tested, and the findings form the basis for generalisations to provider a broader statement.

The focus of this research is not on the manipulation of variables via an experimental setting in measuring the effects of variables, but rather on the inter-relationships between variables (i.e., the ES-induced competences) in achieving OA. An experimental design is thus considered as inappropriate for this study. The research objective of identifying the common characteristics of a targeted sample of organisations in their attempts to stay adaptive and flexible has made a case study design unfeasible here as it is uneconomical and time-consuming to investigate such a large sample population in detail.

The limited existing research on OA and ES reduces the appropriateness of archival and historical research designs, which require a considerably larger number of previous works in a similar research domain. In this study, the constructs have been identified and conceptualised. Therefore, the most appropriate research method for this study is a survey, as it helps to quantify the measurements and test the hypotheses. Furthermore, surveys provides a relatively quick and efficient method to obtain information from the targeted sample (Tan 2002b; Robson 2002), and generalise research findings based on the sample involved (Gill & Johnson 1997).

The survey research method design involves a number of steps in instrument design (Section 4.4), sample design (Section 4.5) data collection (Section 4.6), data cleaning (Chapter 5) and establishing the validity and reliability of the measurement and structural model (Chapters 6 and 7).

4.4 INSTRUMENT DESIGN

Following the positivist paradigm, the concepts in the research model proposed in Chapter 3 must be operationalised in a manner that can be measured and quantified. Therefore, the instrument development of this study followed a research plan recommended by Churchill (1979) and involves the following steps:

- Specify the domain of the constructs (Section 4.4.1)
- Generate items to measure the variables (Section 4.4.2)
- Pre- and pilot testing to purify the measures (Section 4.4.3)
- Assess reliability and validity (See Chapters 5, 6 and 7)
- Develop a norm (see Chapter 8)

4.4.1 Specifying the Domain of the Constructs

The first step of instrument design is to establish the domain of the idea, whereby the purpose and/or importance of the construct, the conceptual definition, and the list of dimensions which represent the elements of the constructs are clearly specified (Churchill 1979; Lewis et al. 2005). Table 4.2 provides definitions of the constructs that structure the research model proposed in Chapter 3.

Table 4.2 *Specification of the Domain of the Constructs*

Domain	Construct	Description/Definition	Sources
Agility	OA	The performance of an organisation to excel in utilising its resources in order to quickly sense changes from its business environment and respond to those changes appropriately. OA is measured by customer, operational and partnering agility.	Ahsan & Ngo-Ye 2005; Oosterhout et al. 2006; Sambamurthy et al. 2003; Tallon 2008
ES Capability	ESS	The ability of an organisation to quickly and efficiently utilise its ES to digitise the process of sensing and develop strategic market foresight about its business environment.	Day 1994, 2002; Narver et al. 2004; Overby et al. 2006; Slater 2001
	ESR	An organisation's capability to deploy its ES resources and embed them in its production development, systems development, supply chain and flexible resource utilisation strategies as well as its processes to quickly and efficiently respond to changes.	Dove 2005; Kohli et al. 1993; Overby et al. 2006
ES competence	EST	The ability of ES technical infrastructure to deliver and support rapid design, development and implementation of ES, and the ability to distribute any type of information across organisations.	Bharadwaj 2000; Fink & Neumann 2007; Piccoli & Ives 2005; Ravichandran 2007; Stratman & Roth 2002; Tallon 2008
	ESHM	The technical and managerial knowledge and skill of using ES in performing business processes.	Bharadwaj 2000; Dong & Zhu 2008; Fink & Neumann 2007; Piccoli & Ives 2005; Ravichandran 2007; Stratman & Roth 2002; Tallon 2008
	ESF	The extent of ES implementation and the quality of using ES in supporting business functions.	Karimi et al. 2007, 2009
Alignment	Alignment between ESS and ESR	The alignment of ESS and ESR capabilities refers to the extent to which an organisation using ES senses only those opportunities that it can respond to and correspondingly responds only to those opportunities that it has sensed as important.	Overby et al. 2006; Roberts & Grover 2012; Seo & Paz 2008

The construct OA consists of three dimensions: customer agility, operational agility and partnering agility (Sambamurthy et al. 2003), which represent the areas where organisational changes can take their effect. Customer agility refers to the ability to explore and exploit the customer relationship in order to gain market intelligence and detect competitive action opportunities (Sambamurthy et al. 2003). Operational agility is defined as the ability to accomplish speed, accuracy, and cost economy in the exploitation of opportunities (Sambamurthy et al. 2003). Partnering agility indicates the ability to leverage business partners' knowledge, competencies, and assets (Sambamurthy et al. 2003).

The main structural model is hypothesised with the availability of the moderating effect of the alignment of ESS and ESR on OA (H4). Alignment refers to the 'degree to which the needs, demands, goals, objectives, and/or structure of one component are consistent with the needs, demands, goals, objectives, and/or structures of another component' (Nadler & Tushman 1980). It is also known under equivalent terms, such as fit (Venkatraman 1989) and congruence (Nadler & Tushman 1980). The IS literature has postulated several approaches to assess alignment, including typologies and taxonomies, fit models, survey items, mathematical calculations and qualitative assessment (Chan & Reich 2007). Venkatraman (1989) introduced six different conceptualisations of fit in strategy research. These consist of: (1) moderation, (2) mediation, (3) matching, (4) gestalts, (5) profile deviation and (6) covariation.

The perspective of alignment as moderation specifies that the impact of a predictor variable on a criterion variable (i.e., predicted variable) is fundamentally dependent on the level of the moderator variable (Venkatraman 1989). Hence, the alignment between the predictor and the moderator determines the value of the criterion variable. The alignment as mediation perspective postulates that there is a significant intervening effect between the independent variable and the dependent variable (Venkatraman 1989). The functional form of alignment is viewed as indirect effects. The alignment as matching perspective suggests that the level of alignment between two variables is developed independent of any performance anchor. The alignment as gestalts perspective is dedicated to explaining fit between several variables (Venkatraman 1989). The gestalts are the degree of internal coherence among a set of theoretical attributes. Hence, this perspective suggests that instead of examining linear associations between the observed variables, we should try to indentify frequently recurring clusters of gestalts. The alignment as profile-deviation perspective addresses the alignment of variables as the degree of adherence to an externally specified multidimensional profile (Venkatraman 1989). Deviation from the profile implies weakness in alignment between the variables. Finally, the alignment as covariation perspective specifies that alignment is a pattern of covariation or internal consistency between a set of underlying theoretically related variables (Venkatraman 1989).

As suggested by Venkatraman (1989), when deciding to use a specific concept of alignment, there are two decisions that must be made: (1) to choose the degree of specificity of the theoretical relationship, which indicates the level of precision in its functional form, and (2) either to anchor the concept of alignment to a particular criterion or to adopt a criterion-free specification. For the first decision, in particular when the expected degree of alignment is only between two concepts as in the current research context, i.e., ESS and ESR, Venkatraman (1989) recommends choosing between moderation, mediation and matching. For the second decision, prior research has suggested the mediating impact of ESR on the relationship between ESS and OA. The current thesis inherits this argument and develops a similar assumption as stated in H4. It implies that there must be an interaction between ESS and ESR and the alignment of ESS and ESR relates to particular criterion, OA.

The matching perspective implies that the alignment between ESS and ESR is specified without reference to OA, which acts as a criterion variable. The moderating perspective suggests that the impact that a predictor variable (either ESS or ESR) has on a criterion variable is dependent on the level of a third variable, termed the moderator (ESR or ESS respectively). The mediation perspective argues that strong sensing capabilities cannot be effectively leveraged to enable agility if an organisation has weak responding capabilities. Likewise, a strong response capability cannot be effectively leveraged if the organisation fails to sense opportunities (Roberts & Grover 2012).

Prior studies conceptualise the alignment of sensing and responding capabilities as matching (Overby et al. 2006; Roberts & Grover 2012). However, none of the extant studies provide powerful reasoning to suggest rejecting the other theories of alignment outright.

This research argues that the moderating perspective better explains the alignment of ESS and ESR. First, the extant studies have only observed the alignment between sensing and responding capabilities at the organisational level. These two capabilities are independent of each other because they may be developed from various sources. In contrast, ESS and ESR, which represent the strategic use of ES in facilitating organisational capabilities, share a common root in strategic IT management. Hence, there should be an interaction between ESS and ESR that can only be explained through alignment as moderation rather than alignment as mediation. For instance, new implementation of a CRM system not only enables the organisation's sensing capability by rapidly capturing customers' preferences, but also enables the organisation's responding capability by integrating information throughout the organisation and facilitating the speed of responding actions.

Secondly, from the alignment as moderation perspective, the alignment between the predictor and the moderator is the primary determinant of the criterion variable (Venkatraman 1989). Applied to the current research context, the impact of ESR on OA varies across the different levels of customer sensing capability.

The alignment as matching perspective differs from alignment as moderation in that an explicit external performance criterion is lacking. Stated differently, a measure of alignment between two variables is developed independent of any performance anchor, which in this study is OA (Venkatraman 1989). The alignment as matching perspective is not relevant to explaining the situation that organisations have high sensing capabilities (e.g., sensing more opportunities in terms of quantity, or sensing opportunities more rapidly) would have a higher probability of using their responding capabilities (e.g., quickly mobilising their human, financial and technological resources) when responding to opportunities. Hence, variation in sensing capability directly moderates the influence of responding capability of the organisation.

The alignment of ESS and ESR capabilities refers to the extent to which an organisation using ES senses only those opportunities to which it can respond and correspondingly responds only to those opportunities that it has sensed as important (Overby et al. 2006). Hence, an aligned organisation senses and responds effectively and efficiently with no investment being wasted and no opportunities being missed.

From the alignment as moderation perspective, the alignment between ESS and ESR is conceptualised as the interaction between these two variables (Bergeron et al. 2001). This method introduces the product term of the moderator variable and predictor variable and investigates the strength and significance of this interaction in terms of the dependent variable (Venkatraman 1989). The interaction term is commutative. It does not specify which variable is the predictor and which one a moderator (Henseler & Fassott 2009). Hence, it is relevant to representing alignment relationship.

4.4.2 Generating Items to Measure the Research Variables

Boudreau et al. (2001) recommend that quantitative-positivist researchers should use previously validated instruments whenever possible for the sake of efficiency. However, instruments adapted from previous validated instruments must be revalidated for their content, constructs, and reliability. Therefore, based on the definitions provided above, this study has adopted content analysis to draw inferences to address the domain specified above from an extensive review of the IS/ES and OA literature. Where possible, existing measurements of the constructs have been adapted for use in this study. This procedure was coupled with discussions with two domain experts, who were also the research study supervisors. The initial pool of measures had 70 items in total. The following section describes how the items were allocated in each construct to operationalise the constructs specified in the proposed research framework.

The OA construct was operationalised based on 13 items measuring dimensions of customer agility, operational agility and partnering agility derived from Ahsan and Ngo-Ye (2005), Tallon (2008) and Oosterhout et al. (2007) [see Appendix 4.1(a)].

The construct ESS capability is defined as organisation's capability to deploy its ES resources and embed them in its production development, systems development, supply chain and production and flexible resource utilisation strategies and processes to quickly and efficiently respond to changes (see Table 4.2). ESS was operationalised by 9 items [ESS1–9, see Appendix 4.1(b)]. These items were derived from Narver et al. (2004), Choo (2001) and Slater and Narver (2000).

The ESR capability construct is defined as an organisation's ability to deploy its ES resources and embed them in its production development, systems development, supply chain and production and flexible resource utilisation strategies and processes to quickly and efficiently respond to changes. Sixteen items (ESR1–16) to measure ESR capability were derived from Agarwal et al. (2007), Auramo et al. (2005), and Overby et al. (2006) [see Appendix 4.1(c)].

The ESC construct consists of three subconstructs: EST technical competence (EST), ES human and managerial competence (ESHM) and ES functional competence (ESF). EST is measured by 12 items (EST1–12) derived from three sources (Fink & Neumann 2007; Ravichandran 2007; Stratman & Roth 2002) [Appendix 4.1(d)]. ESHM is operationalised by 13 items (ESHM1–13) derived from Fink and Neumann (2007) [Appendix 4.1(e)], and ESF is measured by two items: the extent of ES implementation and the quality of the usage of ES in business activity. These two items were adapted from Karimi et al. (2007, 2009). The details of measurement items for ESC are provided in Appendix 4.1(f).

The ED construct is operationalised by five measurement items adapted from Tallon (2008) [Appendix 4.1(g)].

This thesis research suggests the alignment between ESS and ESR from the 'alignment as moderation' perspective. Hence, the latent interaction variable ESS*ESR is reflected by indicators which are the pair-wise product of each indicator of ESS (nine items) to each indicator of ESR (16 items).

4.4.3 Pre- and Pilot Testing

The pre and pilot testing phase was conducted in two steps; testing the research instrument with panel of experts, and running a pilot test.

4.4.3.1 Pre-testing

The purpose of this step is to improve the reliability of the instrument through consulting experts in the field and asking their opinion regarding the relevance of the items. Thirty-six academics who have studied the strategic impact of IS on business performance and ten senior practitioners who have skills and knowledge in using and implementing ES were invited to pre-test (judge) the survey questionnaire as a panel of experts. The academics were identified through literature and the practitioners were selected from the personal network of the researcher. The profile of the panel was as follows:

- Thirty-six professors of IS researching one of the following topics: OA, organisational flexibility, organisational adaptability.
- Six out of ten senior ES practitioners were the SAP and Oracle ES consultants with considerable experience in implementing ES in organisations from different business industries. These consultants were experts in different products (e.g., SAP, Oracle) and different ES modules (CRM, ERP and SCM). Their skills and knowledge were reflected by the number of successful projects that have gone live.
- Four out of ten ES practitioners were end users who have used ES at work for considerable lengths of time in organisations from various industries.

An e-mail containing the invitation letter, a plain language statement together with the survey form and a link to an online version of the survey was sent. In the survey questionnaire, the participants were asked to evaluate the relevance and appropriateness of the research instrument on a scale from 1 to 5, with 1 indicating highly irrelevant and 5 highly relevant. The participants were encouraged to provide further feedback and comments on the indicators as well as the general design of the survey. The participants were also strongly encouraged to provide comments on the research instrument.

As a result, 12 academics accepted the invitation, with nine of 12 completing the questionnaire. The other three academics provided suggestions but did not fill out the questionnaire. There were five practitioners who responded to the invitation, and three of these completed the questionnaire.

With 12 survey response from the panel of experts, the data were analysed quantitatively using descriptive statistics with means and standard deviations (see Table 4.3). A five-point Likert scale was used to measure the relevance and appropriateness of the variables and thus the variables that have low mean values imply that they are not relevant as measures of the constructs. To filter the valid variables, a threshold of 3.5 was set. In addition, a high standard deviation means a high variability in the responses from the participants. Therefore, those variables that have a mean between 3.5 and 3.7 and a standard deviation of greater than 1 were scrutinised vis-à-vis face validity based on the comments of the participants.

Table 4.3 Descriptive Results of the Panel of Experts Judgements

	N	Min	Max	Mean	Std. Dev		N	Min	Max	Mean	Std. Dev
OA01	12	3	5	4.17	0.718	EST01	12	3	5	4.25	0.754
OA02	12	3	5	4.42	0.669	EST02	12	1	5	3.92	1.311
OA03	12	2	5	4.17	1.115	EST03	12	2	5	4.00	0.953
OA04	12	3	5	4.08	0.669	EST04	12	3	5	4.17	0.835
OA05	12	1	5	3.42	1.443	EST05	12	2	5	4.42	0.996
OA06	12	1	5	4.25	1.138	EST06	12	3	5	3.75	0.866
OA07	12	3	5	4.00	0.853	EST07	12	3	5	4.42	0.793
OA08	12	2	5	4.17	0.937	EST08	12	2	5	3.50	0.798
OA09	12	1	5	3.75	1.485	EST09	12	1	5	3.58	1.311
OA10	12	1	5	3.50	1.382	EST10	12	3	5	4.25	0.754
OA11	12	2	5	3.67	0.888	EST11	12	1	5	3.92	1.505
OA12	12	1	5	3.58	1.084	EST12	12	1	5	3.83	1.337
OA13	12	1	5	3.75	1.138	ESHM01	12	4	5	4.67	0.492
ESS01	12	3	5	4.50	0.674	ESHM02	12	3	5	4.50	0.674
ESS02	12	2	5	4.25	0.866	ESHM03	12	3	5	4.42	0.793
ESS03	12	3	5	4.25	0.866	ESHM04	12	3	5	4.42	0.669
ESS04	12	1	5	3.17	1.467	ESHM05	12	3	5	4.33	0.888

ESS05	12	1	5	3.50	1.243	ESHM06	12	2	5	4.33	0.888
ESS06	12	2	5	3.83	1.115	ESHM07	12	2	5	4.25	1.055
ESS07	12	3	5	4.17	0.718	ESHM08	12	3	5	4.25	0.866
ESS08	12	1	5	3.42	1.311	ESHM09	12	1	5	3.83	1.467
ESS09	12	1	5	3.25	1.357	ESHM10	12	1	5	3.83	1.528
ESR01	12	1	5	3.75	1.138	ESHM11	12	1	5	4.25	1.215
ESR02	12	1	5	3.67	1.303	ESHM12	12	1	5	3.67	1.155
ESR03	12	1	5	3.58	1.505	ESHM13	12	1	5	4.25	1.215
ESR04	12	1	5	4.08	1.165	ED01	12	3	5	4.42	0.669
ESR05	12	3	5	4.00	0.603	ED02	12	1	5	3.67	1.303
ESR06	12	1	5	3.92	1.084	ED03	12	3	5	4.67	0.651
ESR07	12	3	5	3.92	0.793	ED04	12	2	5	4.08	0.996
ESR08	12	3	5	3.92	0.793	ED05	12	1	5	3.08	1.240
ESR09	12	3	5	4.17	0.835						
ESR10	12	2	5	3.92	1.165						
ESR11	12	1	5	3.42	1.443						
ESR12	12	1	5	4.00	1.206						
ESR13	12	1	5	3.58	1.165						
ESR14	12	1	5	3.50	1.446						

ESR15	12	1	5	4.08	1.084						
ESR16	12	1	5	3.25	1.603						

Based on these results, the instrument was modified with some items being reworded, and others deleted. In total, 17 items were deleted after pre-testing with the panel of experts. Table 4.4 summarises the changes in the survey questionnaire after analysis of the responses from the panel of experts.

Table 4.4 Changes in the Survey Questionnaire after Analysis of the Responses from the Panel of Experts

Construct	Item	Action	Reason for Action
OA	OA1: ‘We constantly look for opportunities to add value to our customers’	Changed to ‘Constantly look for opportunities to add value to our customers’	
	OA4: ‘Continuously forecast our customers’ needs’	Changed to ‘Continuously anticipate our customers’ needs’	
	OA5: ‘Has a high level of interaction with our customers’	Deleted	Low mean value for relevance
	OA6: ‘Quickly adapt to changes from the market due to new regulations and technologies’	Change to ‘Quickly adapt to changes from the market (i.e., regulation changes, technological innovations, cultural shifts, competitors’ actions, etc)’	
	OA10: ‘Provide mass customisation of products and/or services’	Deleted	Low mean value for relevance
ESS	ESS4: ‘Analyse business intelligence in different formats (text, audio, video)’	Deleted	Low mean value for relevance
	ESS5: ‘Prioritise the most important changes in the business environment’	Change to ‘Notify the important changes in the business environment’	
	ESS8: ‘Develop alertness about the business environment’	Deleted	Low mean value for relevance
	ESS9: ‘Develop rich industry foresight’	Deleted	Low mean value for relevance
		Add: ‘Examine trends in the data for the industry foresight’	
ESR	ESR1: ‘Quickly bring new products/services to market’	Change to ‘Bring new products/services to	

		market faster than other competitors'	
	ESR2: 'Quickly add more feature(s) to existing products/services'	Deleted	Low mean value for relevance
	ESR3: 'Introduce new products/services faster than other competitors'	Deleted	Similar to ESR1
	ESR7: 'Collaboratively design plans with trading partners'	Change to 'Collaboratively design plans with trading partners'	
	ESR6: 'Simultaneously work on the same data with trading partner'	Deleted	Similar to ESR7
	ESR8: 'Allow trading partners to work on your real data'	Deleted	Similar to ESR5
	ESR11: 'Simultaneously design business processes with several supply chain partners'	Deleted	
	ESR12: 'Increase the accuracy of information used by top management'	Change to 'Increase the accuracy of information used by decision makers'	
	ESR14: 'Adapt to radical market changes routinely'	Deleted	Low mean value for relevance
	ESR16: 'Absorb radical change routinely'	Deleted	Low mean value for relevance
EST	EST8: 'We have developed a distributed and open ES integration platform'	Deleted	Low mean value for relevance
	EST9: 'Our ES have a good fit with our business requirements (such as Sarbanes Oxley, BASEL II, GAAP)'	Deleted	Low mean value for relevance
	EST11: 'Our ES are fully integrated'	Deleted	System integration is covered in other variables
	EST12: 'Our ES are adaptive'	Deleted	Similar to EST10
ED	ED5: 'The speed of our products or services to be manufactured or sold'	Deleted	Low mean value for relevance

4.4.3.2 Pilot testing

The purpose of this step was to test the appropriateness of the research instrument in order to further improve its quality. The pilot test was conducted via face-to-face discussion with 2 CIOs who had extensive experience working with ES. The interviews were conducted over approximately 1.5 hours and were recorded. The questionnaire was presented to the participants, who were asked to explain how they understood and interpreted each questions. The participants were also asked if the questions were clear and if they had any difficulty in answering them. Overall, the participants confirmed that the questions were clearly stated and that they understood them well. The participants also offered further feedback from a practitioner perspective and proposed the inclusion of several items. After analysing the feedback obtained from the pilot testing, the research instrument was further purified. Some modifications were made, as presented in Table 4.5.

Table 4.5 Changes in the Survey Questionnaire after the Pilot Testing

Construct	Item	Action
OA	OA11 and OA12	Switch position of OA11 to OA12
	OA4: 'Continuously forecast our customers' needs'	Changed to 'Continuously anticipate our customers' needs'
ESR		Add: ESR9 'Generate new business strategies'
	ESR10: 'Empower employees for taking actions'	Changed to : 'Empower employees for taking actions in business operations'
EST	EST4: 'Our ES are fully integrated with each other (e.g., CRM system integrated with ERP system)'	Changed to: 'Fully integrated with each other (e.g., CRM with ERP)'
	EST10: 'Our ES architecture is highly adaptable to future changes (e.g., government laws, tax standards)'	Changed to: EST8 'Our ES are highly adaptable to future requirements'

4.5 SAMPLE DESIGN

Four aspects were considered in the sample design: the sampling frame, the sample size, the respondent selection criteria and the sample source.

4.5.1 Sampling Frame

Collecting data on an entire group or population produces the most precise knowledge. However, it is difficult if not impossible to study on a whole population due to two major factors: time and cost. Studying samples, which are subsets of the population of interest, provides a practical and effective way to overcome this dilemma. To generalise the study findings to the population, the sample must accurately represent that population. The sampling frame lists all units in the population from which the sample will be selected. In this research, the population are all organisations that have implemented and used ES and are able to evaluate the values brought into their organisation by their ES. The literature on the sample frame of similar studies in this research area was reviewed to ensure that that the current study is comparable. These studies are on the topic of the impact of IT in general, and ES in particular, on business performance or more specifically, business agility. The results are shown in Table 4.6.

Table 4.6 Comparison of Sampling Frames from Previous Studies

Citation	Country	Firm Size	Industries
Bhatt et al. 2010	USA	Large	Manufacturing, service.
Breu et al. 2002	UK	Large and medium	Manufacturing, professional services, IT/telecommunications, public sector and financial services.
Lee et al. 2007	China	Large	Machinery, IT, electronics, chemicals, medicine and biological products, metal and non-metal, textile, wholesale, conglomerate, others.
Fink & Neumann 2007	Israel	Medium and large	Finance, business services, communications, defence, distribution/retail, education, government/municipalities, health services, insurance, logistics, manufacturing, real estate, technological development, transportation, utilities.
Tallon 2008	USA	Large	Electronics and computing machinery, wholesale and retail, financial services, software services, metals and plastics, pharmaceuticals and health care.
Swafford et al. 2006	USA	Large	Apparel, furniture and fixtures, rubber and miscellaneous plastic products, fabricated metal products, industrial and commercial machinery and computer equipment, electronic and other electrical equipment and components, transportation equipment, measuring, analysing, and controlling instruments.
Byrd & Turner 2000	USA	Large	Eight private sector industries.
Oosterhout et al. 2006	Netherlands	Large	Highly dynamic industries: logistics (logistics service providers), finance (retail banking), utilities (distribution and sales of energy), mobile telecom (mobile telecom operators).
Karimi et al. 2007	USA	Large	Manufacturing.
Coltman 2007	Australia	Not specified	Seven broad industry sectors: financial services, insurance, airlines, utilities, telecommunications, hotels, large retailers.
Stratman et al. 2002	North America	Medium and large	Manufacturing firms with ERP installations (primarily high tech electronics, chemical, pharmaceutical, or consumer goods industries).

The comparison of the sampling frames in similar studies indicates some common characteristics. First, certain studies cover a wide range of industries (Fink & Neumann 2007; Lee et al. 2007; Oosterhout et al. 2006; Swafford et al. 2006; Tallon 2008), while fewer studies focus on only one or a few specific industries, such as manufacturing and services (Bhatt et al. 2010; Karimi et al. 2007). The reason for constraining the sample frame to a single industry is to avoid bias due to industry differences (Karimi et al. 2007). However, the industries selected rely heavily on IT (Byrd & Turner 2000) especially on ERP and CRM (Coltman 2006; Stratman & Roth 2002) and/or are highly dynamic and competitive (Coltman 2006). Second, the most common size of the investigated organisations was medium and large, with large-sized organisations being dominant. However, the demographic results on the size of the organisation show that all of the researched firms have a size of more than 100 permanent employees. Finally, although the studies were conducted in various geographical locations, the majority were in the USA.

The current research studies the concept of ES competences and their influence on OA. Hence, a series of criteria in selecting the samples to be targeted were applied. First, OA is only appreciated in a dynamic environment, and as ED is brought into the model, industries which have high market uncertainty and strong competition were targeted (Lee et al. 2007; Oosterhout et al. 2006). Education, agriculture, healthcare and government are industrial sectors that have less variation; hence, they were excluded. Combining these two criteria, the list of industries which the sample targeted included;

- Financial/banking services (retail banking, insurance)
- Airlines
- Utilities (distribution and sales of energy, water, etc)
- Telecommunications
- Software services
- Hospitality (hotels)
- Wholesalers
- Retailers
- High tech electronics (electronic and other electrical equipment and components)
- Chemical

- Pharmaceutical
- Consumer goods
- Logistics (logistics service providers)
- Manufacturing (apparel and textiles; furniture and fixtures; rubber and miscellaneous; plastic products; fabricated metal products; industrial and commercial machinery and computer equipment; transportation equipment; measuring, analysing and controlling instruments; machinery; chemical products; medical and biological products; metal and non-metal; wholesale; conglomerate and others).

Most previous studies locate the sample frame in North America (USA and Canada) while the sample frame of this research was Australian companies. To make the current research comparable with previous research in the field, a focus on approaching medium and large size enterprise was adopted. Although USA and Australia are two distinctive countries, which create different business contexts, they are well-developed countries where the impact of globalisation is forcing organisations to operate on a global scale. Hence the business operations of their large and medium sized organisations should share similar features. Nonetheless, Australia and North America have different classifications of organisation size. In the United States, where medium and large business is defined by the number of employees, it often refers to organisations with 100 and 500 employees or more, respectively.

The Australian and New Zealand Industry Classifications regulated by the Australian Bureau of Statistics indicate that large organisations are those with 200 employees or more, while medium organisations are those have more than 20 and less than 200 employees. However, small and medium size organisations tend to have centralised structures and to lack the financial resources to invest in IT infrastructure (Montazemi 2006). ES were initially implemented in large organisations. ES vendors have provided affordable ES packages to small and medium enterprises; however, the package functionalities are simple and are not representative of the comprehensive architecture of ES for large organisations. Furthermore, the number of employees is not the only means to determine business size. Annual revenue is another factor used extensively to evaluate the size of an enterprise.

Reports on successful ES implementations from the two largest ES vendors (SAP and Oracle Australia) were reviewed and revealed that the majority of these organisations had more than 100 full time employees and annual revenues of greater than $20 million. Furthermore, organisations require adequate time to understand and measure the benefits brought about by ES implementation (Davenport 2000; Shang & Seddon 2002). ES benefit realisation is a process involving different stages, and business performance is not stable. Further, different benefits required different times to be fully realised by users (Shang & Seddon 2002). For instance, Shang and Seddon (2002) reveal that it takes 1–2 years for organisations to realise the operational benefits while 2–3 years are necessary for users to become accustomed to the new ES and extract the maximum benefits from it. The classification of ES maturity can be divided into three stages: the beginning period, within the first 12 months; the consolidation period, within 1–3 years after implementation, and the mature period, which begins 3 years after ES implementation (Hawking & Stein 2004). As such, this research focuses only on those organisations that have used an ES for at least a year and thus are in the consolidating or mature stages, the earliest period that organisational benefits from the ES start to be realised from operational and managerial perspectives.

Therefore, the sample frame was defined as Australian and New Zealand organisations that (a) operate in industries outside the education, agriculture and government sectors; (b) have implemented and used an ES for more than a year; and (c) have more than 100 employees or an annual revenue of AUD$20 million or greater.

4.5.2 Sample Size

Adequate sample size is the most effective method of achieving estimates that are sufficiently precise and reliable for scientific inquiry. Selecting a subset of the population means that some members of a population are not included in the sample. Sampling variability, or the fluctuation of sample estimates around the study population parameters, results from the random selection process (Bickman & Rog 1998, p. 108). The relationship between sampling variability and precision is well established: the precision of a sample statistic decreases as sampling variability increases. Sampling variability decreases as the sample size increases. However, increasing sample size has a cost. Therefore, it is important to determine the minimum required sample size. 'Sample size decisions are always a compromise between the ideal and the practical, between the size needed to meet technical requirements and the size that can be achieved with the available resources' (Blaikie 2009, p. 185).

There are a number of factors that influence the sample size decision. First, with any particular statistical procedure, a minimum number of samples is required for data analysis. The validation guideline compiled by Straub et al. (2004) indicates that SEM can perform most of the validity tests required. Therefore, the current study has employed SEM for data analysis. The model of the research contains six constructs, and according to Hair et al. (2010) a minimum sample size of 150 is appropriate. Second, the more homogeneous a population is, the better it can be represented by smaller samples than one in which there is a wide dispersal (Blaikie 2009, p. 210). Third, the more precise the level of measurement, the smaller the sample required (Hair et al. 2010). The two latter factors can be controlled by examining the conventions of the sample sizes of previous research in the same area. The result of the literature review is presented in Table 4.7.

Table 4.7 Comparison of Sample Sizes from Previous Studies

Citation	Country	Sample Size	Response size	Response Rate (per cent)
Bhatt et al. 2010	USA	1,400	105	9.0
Breu et al. 2002	UK	15,000	515	3.6
Lee et al. 2007	China	1,000	178	17.8
Fink & Neumann 2007	Israel	8,000	361	4.5
Tallon 2008	USA	1,600	241	13.0
Swafford et al. 2006	USA	678	135	20.0
Byrd & Turner 2000	USA	1,000	207	20.7
Karimi et al. 2007	USA	550	148	27.0
Coltman 2007	Australia	450	100	22.0
Stratman et al. 2002	North America	623	79	13.0
Average		3,030.1	206.9	15.1

The comparison of the samples sizes of previous studies indicates that on average, the studies collected around 207 responses at a 15.1 per cent response rate. The sample sizes ranged between 450 and 8,000. As the industries selected (mostly manufacturing and services) and the company sizes (medium and large organisations) are homogenous in the previous research, it was considered reasonable to aim for a response rate of around 200.

The ideal response size for method analysis and the research tradition requires around 200 samples. Hence, the minimum required sample size of the current study was 200. Moreover, the response rate of the prior research ranged from 3.6 per cent to 27 per cent, with the lower response rates occurring in the countries outside of North America and/or studies conducted using online surveys. Hence, a higher sample size was selected to ensure statistical validity even with a low response rate. The response rate was assumed to be between 5 per cent and 10 per cent, and a sample size of 3,000 was considered appropriate to achieve a response size of 200. However, since this study focussed on medium and large organisations that have implemented ES, the sample size of 3,000 was adjusted according to the list of companies that were available from the database provider (see Section 4.5.4).

4.5.3 Respondent Selection Criteria

There is distinction between independent and dependent variables in the current study. The dependent variable (OA), which refers to the business performance of an organisation, would be best evaluated by business executives. The independent variables (ES competences) are most appropriately measured by IT senior executives well versed in organisational capabilities related to IT. Therefore, to avoid common method bias, the ideal respondent selection strategy would be to send out two separate sets of questions: questions on the independent variables to IT senior executives, and questions on the dependent variables to business senior executives. The matching for each company sampled would then be conducted after the surveys were returned to give a comprehensive understanding. The question of whether a single respondent can realistically offer a valid and accurate view of all research variables remains open (Tallon 2008). Tests of discriminant validity in IS research do not use multi-trait multi-method analysis, perhaps because its rules of thumb are ambiguous and it is labour intensive, requiring two very different methods of gathering data (Straub et al. 2004). Furthermore, the multiple respondent problems may increase if the matched method is used. Previous similar studies were reviewed for their respondent selection procedures to ensure the comparability of the current study and to understand the norm, with the results presented in Table 4.8 below.

Table 4.8 Summary of Respondents from the Literature

Reference	Response Rate (per cent)	Respondents	Database	Notes
Bhatt et al. 2010	9.0	CIO, VP of IT, director of IT, corporate business managers, chief managing director, CEO, CFO, managers of other technology services	Marketing vendor	Single respondent
Lee et al. 2007	17.8	IT executives [CIO, chief technical officer (CTO), MIS manager)] business executives [CEO, chief operating officer (COO), sales/marketing manager]	Not specified	Different surveys for IT and business managers
Fink & Neumann 2007	4.5	IT managers	Community provider	
Tallon 2008	13.0	IT executives (CIO, IT director, SVP/VP IT, IT manager), business executive survey (SVP/VP corporate development, business development officer, VP strategic planning, chief financial officer)	Applied Computer Research and Hoovers.com	Different surveys for IT and business managers
Swafford et al. 2006	20.0	Upper and middle management positions	Not specified	Single respondent
Byrd & Turner 2000	20.7	CIO, VP IT services, director of MIS, database administration directors; directory of top computer Executives	1000 Fortune companies USA	
Karimi et al. 2007	27.0	Senior IS executive in each firm (e.g., CIO, VP IS)	Harris database	
Coltman 2007	22.0	Executives in marketing, strategy and IS	Commercial database	Single respondent
Stratman et al. 2002	13.0	Senior supply chain and IT managers	Multiple sources*	

*ERP vendors, PC Week's Top 100 Innovative Manufacturers, Industry Week's Top l000 Manufacturers, American Production and Inventory Control Society (APICS), Canadian Association of Supply Chain and Logistics Management

The results of the literature review indicate that CIOs/senior IT managers are regarded as being the most knowledgeable about the relevant issues. A number of studies also used a single respondent for both the dependent and independent variables. Therefore, after considering the pros and cons of each respondent selection method vis-à-vis the limited resources available to conduct this study, the decision was made to use only one respondent per company. It was also decided that the appropriate types of respondents from the companies selected were senior IT executives such as CIOs, chief technical officers (CTO), and MIS managers. The dependence of business activity on IT, especially in large and medium-sized organisations requires the participation of senior IT managers in the organisations' strategic planning and management. Hence, they are expected to comprehend business issues unrelated to their comprehensive knowledge of the organisation's IT issues.

4.5.4 Sample Source

In order to identify the targeted respondents, a number of commercial databases were considered, as summarised on the basis of the sampling requirements (Table 4.9). IncNet, OneSource, IDG, Dun & Bradstreet database providers do not provide contact details of selected respondents of medium to large Australian organisations that have implemented and used ES. Only Fairfax Business Research provides the contact details of CIOs of the Australian customer lists of specific ES vendors such as SAP, Oracle, Peoplesoft, Baan, JD Edwards and others. Except for IncNet, none of the other data providers provide e-mail information for the contacts to support online data collection. The cost charged by Onesource and D&B were higher than the allocated budget, therefore, only IncNet and Fairfax Business Research were shortlisted as potential candidates due to their specific advantages over the rest of the business data providers: e-mail details in the case of IncNet and specific lists of Australian ES implementing organisations in the case of Fairfax Business Research.

Based on the experience of other researchers who have obtained data from both of these providers, and the budget allocated, Fairfax Business Research was eventually chosen. Based on the selection criteria, Fairfax provided 1,637 records including 1,405 records in Australia and 232 records in New Zealand. In the categories of large organisation (200 or more permanent employees), a complete dataset was obtained, whereas in the categories of medium organisation, only those with 100 or more permanent employees and an annual revenue of $11 million AUD were obtained. The Fairfax list contains contact addresses and conforms to the sample criteria defined earlier.

Table 4.9 Comparison of Data Providers

Required	IncNet	D&B	Fairfax Business Research	OneSource
Australian CIO contact list	✓	✓	✓	✓
New Zealand CIO contact list	✓	✓	✓	✓
Implementing ES			✓	
Large organisation sorting	✓	✓	✓	✓
Industry sorting	✓	✓	✓	✓
E-mail	✓			
Postal address	✓	✓	✓	✓
Telephone	✓	✓	✓	✓
Total list count	2400		1637	N/A
Total cost (AUD)	2,400		3,274	5,000

In summary, the sample selection criteria were:

- CIO contact list (postal address, telephone, e-mail address as preferable).
- Medium and large Australasian organisations (Australia and New Zealand) that have at least 100 permanent employees and annual revenues of more than AUD 11 million.
- Implemented and used ES (CRM, SCM or ERP) for at least one year.
- Belong to all industries excluding the agriculture, healthcare, education and government sectors.

4.6 DATA COLLECTION METHOD

The main survey was conducted both via paper-based questionnaires and online. The mail survey was posted to the contact mailing address. The mail package, which included an invitation letter containing the plain language statement [see Appendix 4.2(a)] and the link to an online version of the questionnaire, the paper-based questionnaire [see Appendix 4.2(b)] and a return envelope with the researcher's mailing address, was sent to 1,637 respondents. To supervise the follow-up more efficiently, the questionnaires were divided and sent in batches of 300–400 records within 2 weeks with 3 days difference between each batch.

To achieve a higher response rate, several survey follow-up strategies were implemented, including an easily comprehensible questionnaire, personalised correspondence, and five rounds of reminders with an intensified sense of importance to the survey invitation. The time frame and method employed for the data collection and process is summarised in Table 4.10.

Table 4.10 Summary of the Data Collection Campaign

Wave	Time	Method	Number of Responses	Note
First contact	24/1/2011–5/2/2001	Mail only	51	
Second contact; first reminder	15/2/2011–28/2/2011	Mail and e-mail	22	Postponement of the mail contact due to New Zealand due to the earthquake in Christchurch on 22/2/2011
Third contact; second reminder	3/3/2011–15/3/2011	Mail and e-mail	52	
Forth contact; third reminder	21/3/2011–26/3/2011	E-mail only	38	
Fifth contact; Fourth reminder	31/3/2011–4/3/2011	E-mail only	61	The online questionnaire was not opened until 10/4/2011

Two and a half month after the first invitation e-mail was sent the survey was closed. A total of 275 e-mails bounced back and 139 respondents requested to be excluded from the research. The reason for the bounced e-mail was either a wrong address, or the respondents have moved or changed their position. This made a final sample size of 986 respondents. A total of 224 responses were received, equivalent to a 22.7 per cent response rate.

4.7 ETHICS

The research was undertaken in accordance with RMIT's ethics guidelines. The research was classified under the Negligible and Low Risk Research classification by the College

Human Ethics Advisory Network (CHEAN), RMIT University. The researcher was granted approval to conduct the survey in Australia and New Zealand.

4.8 SUMMARY

This chapter has discussed the methods used to test the validity of the research model proposed in Chapter 3. The research follows a positivist paradigm and adopts quantitative survey as the research methodology. The instrument design followed the rigorous procedure developed by Churchill (1979), beginning with the definition of the domain constructs, generation of the initial items and then pre-testing and pilot testing to finalise the measurement items. The sample design was specified in terms of sample frame, sample size, and respondent selection. Each factor was compared to that from similar IS research to ensure that the research did not diverge from common practice in the IS literature. Finally, the data collection was via a paper-based survey. The next chapter will discuss the examination of the collected data.

CHAPTER 5: DATA PREPARATION

5.1 INTRODUCTION

This chapter presents the process of preparation of the data that was collected in this study. The data need to be examined, prepared and explored before commencing instrument validation and hypothesis testing due to three reasons. First, organising the data correctly can save considerable time, prevent mistakes and minimise potential measurement error that may lead to confusion and difficulty with the statistical analysis in the next phase (Hair et al. 2010; Tabachnick & Fidell 2001). Second, data preparation can help fit the data with the requirements of modern and standardised data analysis tools such as SPSS and Microsoft Excel, thus, data can be easily retrieved, transformed and maintained. Finally, through the process of meticulously examining the data, it is possible to verify if the data satisfy requirements such as normality testing and internal consistency that are essential prerequisites before the multivariate analysis is attempted (Hair et al. 2010).

The data examination was undertaken in systematic steps and is presented in the next five sections of this chapter, as summarised in Table 5.1. First, the data were screened and cleaned to detect inconsistencies and the survey data were coded into a standardised and consistent format (Section 5.2). Second, in Section 5.3, missing values were analysed to delete irrelevant items and cases that have a high percentage of missing data beyond the threshold to be usable and to perform imputation on the remaining data. Third, outliers were identified and treated (Section 5.4). Fourth, several tests were conducted to evaluate if the assumptions of multivariate analysis were complied with before the data were tested (Section 5.5). Finally, to ensure that the data collected represent a generalisation of the population, the non-response bias was estimated (Section 5.6). Section 5.7 provides a brief summary of the chapter.

Table 5.1 Data Examination and Preparation

<table>
<tr><th>Data preparation step</th><th>Heuristic criteria</th><th>Result</th><th>Action</th><th>Number of cases</th></tr>
<tr><td>Data collection</td><td></td><td></td><td></td><td>224</td></tr>
<tr><td>Data entry and screening (5.2)</td><td>Meet sample frame requirement</td><td>34 incomplete and 7 cases outside sample frame</td><td>Removed the 41 cases</td><td>183</td></tr>
<tr><td>Missing value analysis (5.3)</td><td>No missing data on dependent variable</td><td>4 cases missing data on dependent variables</td><td>Removed the 4 cases</td><td>179</td></tr>
<tr><td>Tests for outliers (5.4)</td><td>Univariate (histogram, Q-Q plot), Bivariate (scatter plot) and multivariate (Mahalanobis distance)</td><td>26 cases failed univariate tests, no case failed multivariate tests</td><td>No cases removed</td><td>179</td></tr>
<tr><td>Tests for normality (5.5.1)</td><td>Statistical value for the skewedness and kurtosis within -3 and +3</td><td>22 out of 55 variables failed</td><td rowspan="4">Used non-parametric analysis methods (e.g., PLS)</td><td rowspan="4">179</td></tr>
<tr><td>Test for homoscedasticity (5.5.2)</td><td>Graphical method: scatter plot (falls off diagonal line)</td><td></td></tr>
<tr><td>Test for linearity (5.5.3)</td><td>Scatter plot, ANOVA (not statistically significant with p>0.05)</td><td>p>0.05</td></tr>
<tr><td>Test for multicollinearity</td><td>Item-item correlation matrix (correlation higher than 0.9)</td><td>No extreme value of correlation</td></tr>
<tr><td>Bias test on geographical location</td><td>Independent sample t-test (mean difference not statistically significant)</td><td></td><td></td><td>179</td></tr>
<tr><td>Non-response bias</td><td>independent sample t-test (mean difference not statistically significant)</td><td>p>0.05 to all variable means</td><td></td><td>179</td></tr>
<tr><td>Common method bias</td><td>Harman’s single factor test</td><td>one general factor accounts for 29.68 per cent of the total variance</td><td></td><td>179</td></tr>
</table>

5.2 DATA SCREENING AND CLEANING

The data screening was conducted on both the univariate and multivariate levels before the final statistical analysis (Tabachnick & Fidell 2001). The data screening and cleaning process is a crucial step to exclude cases that are outside the defined sample frame, thus it must be executed meticulously in several steps. Initially, each completed questionnaire, which represents each case of the research sample, was checked and given a unique identifier in the order of the time at which it was received. The data from these questionnaires were keyed in into Microsoft Excel file on a case by case basis with a remark if anything irrelevant was found (e.g., unfinished questionnaires or industries that did not fit the sample frame). The data formats and variable names were then adjusted and coded according to a naming convention so that they could be imported into the statistical software package, which in this study was SPSS. Proofreading of the computerised data file against the original data ensured data accuracy (Tabachnick & Fidell 2001). In the next step, the data were checked for invalid respondents. If the characteristics of the respondent data set did not match the characteristics of the defined population (see Section 5.5.1 for the sample frame), the respondent data set was removed. These criteria were the company size, the industry in which the company's main business was active, the position of the respondent, and the availability and length of use of ES (i.e., CRM, SCM or ERP) as per the following details.

Respondents were the senior IT managers of medium-to-large organisations with 100 or more permanent employees and annual revenue of 20 million dollars and above. The organisations must have implemented and used ES (ERP, CRM or SCM) for at least a year. The respondents should also not come from companies in the agricultural, healthcare, education or government sectors. Out of the 224 responses received, 41 cases which did not match these defined sample frame criteria were deleted. This left 183 responses as usable for further analysis. Table 5.2 tabulates the deleted cases.

Table 5.2 Summary of Deleted Cases

Reason for Deletion	Number of Cases Deleted	Sample Size Each Deletion
Incomplete case	34	190
Irrelevant respondent position	3	187
Irrelevant industries	4	183
Irrelevant length of ES use	0	183
Irrelevant company size	0	183

5.3 MISSING VALUE ANALYSIS AND REMEDIES

After the data were screened and verified against the defined sample frame, the next important step was checking for missing data. Missing data occurs where 'valid values on one or more variables are not available for analysis' (Hair et al. 2010, p. 49). Analysing missing data is essential since it may raise the issue of the generalisability of the result (Hair et al. 2010). As is common in other quantitative research, this research is encountered the missing data issue. The current research employed a four-step process proposed by Hair et al. (2010) to deal with missing data due to its completeness as well as its wider use in IS research. The first step is to determine the type of missing data and whether they are can be disregarded or not. The second step deals with assessing the extent of missing data. The third step involves diagnosing the randomness of the missing data process. The final step is to apply the relevant imputation method for the missing data. The detailed procedures of each step are further presented below.

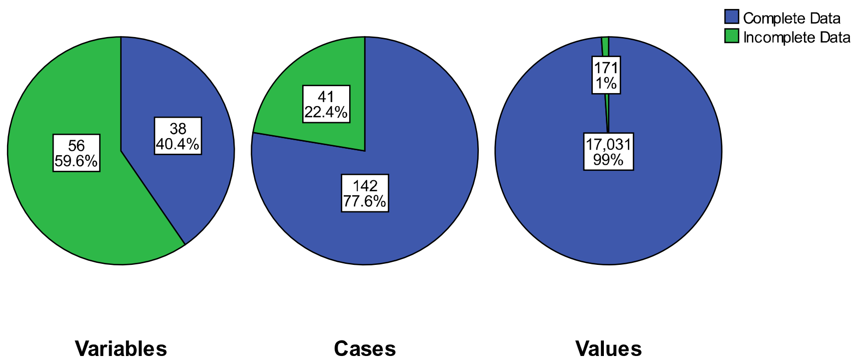
The first step in dealing with missing data is to determine the types of missing data, known as missing data patterns. This is a primary concern because knowing the patterns and relationships underlying the missing data helps maintain the original distribution of values as closely as possible after any remedy is applied (Hair et al. 2010). Two types of missing data have been identified in the literature: 'ignorable missing data' and 'non-ignorable missing data'. While ignorable missing data does not require specific remedies and can be easily detectable, non-ignorable missing data requires systematic missing data analysis (Tabachnick & Fidell 2001). Ignorable missing data are predictable because they are part of the research design (e.g., skipped sections that are not applicable) or when the missing data are those observations in a population that are not included when taking a sample.

One example of ignorable missing data in this research is the use of the 'not applicable' option as part of the potential responses to questions on the module of ES that have been implemented and the extent of use of those modules. The respondents from organisations that do not implement certain modules of three ES (ERP, CRM and SCM) would select the 'not applicable' option for the modules of their ES that are not available. The current research treats 'not applicable' data as 0 on a Likert scale from 1 to 5 since 'not applicable' means 'not available', thus creating no value to the measurement of the variables.

On the other hand, the 'non-ignorable' missing data are missing data that cannot be predicted, and can further be grouped into two types: known missing data process and unknown missing data process (Hair et al. 2010). Missing data whose process is known allows the researcher to identify them, while unknown missing data processes are less easily identified. For example, missing data due to errors in data entry is classified as a known missing data process while missing data due to the respondents having no knowledge or refusing to answer certain questions is classified as an unknown process. Most 'non-ignorable' missing data occurs due to the respondents' behaviours. For example, in the current research the respondents refused to answer sensitive questions with regard to their position or their organisations' annual revenue.

Given that some of the non-ignorable missing data had been identified in Step 1, the second step involved determining the extent of missing data. Assessment of the extents and patterns of missing data allow the determination of whether the missing data are due to specific cases or variables. Therefore, the percentage of missing data for variables and cases were calculated to identify if the amount of missing data per variable or case was low enough to not require any specific treatment or if they would affect the results of the study (Hair et al. 2010). In SPSS, missing values are categorised as 'system-missing' and 'user-defined missing' with system-missing values being values automatically recognised as missing by SPSS, while user-defined missing values are numeric values that need to be defined as missing for SPSS (SPSS 17.0). The missing data analysis tool from SPSS indicates that out of 17,031 data points (named as values in SPSS), 171 or 1 per cent were missing. There were 142 cases (77.6 per cent) that had no missing values, and 41 cases that had missing values. These cases contain both non-ignorable missing data (18 cases) and ignorable missing data. Out of 94 variables in total, 56 variables had missing data (Figure 5.1).

Figure 5.1 Overall Summary of Missing Values



Since the number of cases with missing data account for 22.4 per cent, if the cases with missing data are deleted, this would strongly impact the total sample size available for analysis. However, analysis of the missing data patterns indicated that the missing data were concentrated in the demographic questions, which have less impact on the structural model. Therefore, additional analyses were carried out before making any decision to delete the cases. The extent and patterns of missing data were measured by the percentage of variables with missing data for each case and the number of cases with missing data for each variable. The deletion of cases and/or variables with excessive levels of missing data was performed according to recommendations in the literature (Hair et al. 2010). Accordingly the following criteria were applied to delete cases and variables:

1. Cases with missing data for dependent variables were typically deleted since any imputation method applied to these data would cause an artificial increase in the relationship between the dependent and independent variables.

2. If a case's percentage of missing data was greater than 10 per cent, then that case was deleted except when the missing data occurs in a specific non-random fashion

(e.g., concentration in a specific set of questions, attrition at the end of the questionnaire).

3. Variables with as little as 15 per cent missing data were candidates for deletion although higher levels of missing data (20–30 per cent) could be remedied.

Based on the above criteria, four cases were excluded due to missing data on dependent variables, leaving 179 cases for further analysis. All the other missing data on cases and variables were below the 10 per cent threshold, therefore none of these cases or variables were excluded. Although there is no firm guideline on how much missing data can be tolerated for a sample of a given size (Tabachnick & Fidell 2001), a threshold of 5 per cent was chosen after reviewing the literature due to two reasons. First, the SPSS applications are set to display only indicator variables with more than 5 per cent missing data. Second, if only few data points (5 per cent or less) are missing in a random pattern from a large dataset, almost any procedure for handling missing values yields similar results (Tabachnick & Fidell 2001). Table 5.3 shows the four variables with highest percentage of (>5 per cent) of missing data.

Table 5.3 Summary Statistics for Missing Data with Missing Data Percentage Greater than 5 Per Cent

Variable	Number of valid cases	Missing	Mean	Std. Deviation	Percentage missing
CRM_YEAR	165	14	2.51	2.58	7.82
SCM_YEAR	166	13	2.24	2.554	7.26
ERP_YEAR	167	12	4.83	3.297	6.70
YEAR_REV	169	10	4.92	1.816	5.59

From Table 5.3, it can be seen that the variables with greater than 5 per cent missing data are control variables. Since these variables are not involved directly in the model, it was considered acceptable to retain them in the sample size after the assessment of the extent of missing data. As a result, the remaining data contained 179 cases with no case or variable having more than 10 per cent of missing data. However, these cases still contained a certain level of missing data. To ensure that the extent of missing data could be amended with appropriate remedies, the actions in outlined in Step 3 were taken.

The third step in dealing with non-ignorable missing data is to diagnose whether the missing data are distributed randomly across the cases and the variables. There are two levels of randomness in assessing missing data: missing data at random (MAR) and missing completely at random (MCAR) (Hair et al. 2010). Data that are MCAR are not subject to any underlying process that determines that the data are missing and, therefore, the 'system-missing' data do not lead to bias in the observed variable (Allison 2002). MCAR is observed when the cases with missing data are indistinguishable from the cases with complete data. Data that are missing randomly within subgroups but manifest differences between the subgroups of missing data are called missing at random (MAR). Of the two levels of randomness when assessing missing data, MAR require special methods to accommodate a non-random component while MCAR is sufficiently random to allow for the use of any remedy desired (Hair et al. 2010). Assessing the randomness of missing data processes requires two procedures: testing comparisons between groups of missing and non-missing cases and conducting an overall test for randomness (Hair et al, 2010).

The first procedure is conducted by comparing the observations with and without missing data for each variable on the other variables. In the current study, missing data was considered significant when the missing data was greater than 5 per cent on variables that measure the length of use of ES (ERP_YEAR, CRM_YEAR, SCM_YEAR) and the annual revenue (YEAR_REV). Therefore, for each test, the data were split into two samples: one with no missing values, and the other with missing data. The means of the other variables of these two subsamples were compared to identify if there was a significant difference between the two datasets. The independent t-test, which compares the mean scores of two groups on a given variable, was used. The results are described in Appendix 5.1. The results presented in the Appendix 5.1 showed that a noticeable pattern of significant t-values occurred for the variable YEAR_REV (annual revenue of organisation) only, for which the mean scores of the variables OA, ESS, ESR and EST showed significant differences between the two groups (i.e., with missing data and without missing data). This analysis indicated that although significant differences could be found due to the missing data on the variable annual revenue (YEAR_REV), the effects were limited only to this variable. Further, YEAR_REV is not part of the model constructs, making it of marginal concern.

In the second procedure, missing data were tested for being MCAR. This was is conducted by comparing the actual pattern of missing data with what would be expected if the missing data were totally randomly distributed. Data are MCAR when the pattern of missing values does not depend on the data values. The Little's MCAR test, which measures whether data are MCAR is used in this procedure (Hill 1997; Little 1988). The results of this test are presented in Table 5.4 below.

Table 5.4 Little's MCAR Test Results

EM Means							
Mean OAI	Mean OAP	Mean OA	Mean ESS	Mean ESR	MEAN ESEOA	Mean EST	Mean ESHM
3.7586	3.0981	12.0096	3.2195	3.2397	3.2314	3.0175	3.6149

Little's MCAR test: Chi-square = 2.273, df=9, Sig. = 0.986

The Little's MCAR test had a significance level of 0.986, which is larger than 0.05, thus indicating a non-significant difference between the observed missing data pattern in the reduced sample and a random pattern, or the data are MCAR. With MCAR, no potential bias exists in the pattern of the missing data and therefore any remedy for missing data can be used.

In Step 4, an imputation method for missing data is employed. The missing data can either be treated through deletion or imputation of missing data (Hair et al. 2010). Since the missing data are completely random, there are many possible remedies for MCAR data such as case/list-wise deletion, pair-wise deletion and other imputation methods (case substitution, hot and cold desk imputation, mean substitution, regression-based approaches or model-based approach) (Hair et al 2010). Among those methods, the EM (expectation maximisation) imputation method (Little & Rubin 1987) is suggested in the literature since it will produce estimations that are closest to the parameter values (Schafer 1997). As a model-based method, EM predicts the missing values of a variable based on its relationship to other variables in the dataset (Hair et al. 2010). 'EM forms a missing data correlation matrix by assuming the shape of a distribution for the partially missing data and basing inferences about missing values on the likelihood under that distribution' (Tabachnick & Fidell 2001, p. 68). In addition, producing high quality imputations for a particular variable requires the inclusion of both variables that are potentially related to the missingness of the imputed variable and variables that are potentially related to the imputed variable (Schafer 1997). Therefore, the EM method represents the original distribution of values and gives consistent and unbiased estimates of correlations and covariances (Hair et al. 2010; Hill 1997). This EM imputation method is also available in SPSS 18 and was followed in the current research. SPSS 18 produced a new data sheet with imputed missing values which was then used for further analysis.

Although the dataset had been meticulously treated for missing data, the data values themselves still required further analysis on their own characteristics. The next section presents the outlier treatment of the data.

5.4. TESTING FOR OUTLIERS

Outliers are 'observation with a unique combination of characteristics identifiable as distinctly difference from other observations (Hair et al. 2010). Detecting outliers is important since they can change the results of the analysis and cause poor model fit (Tabachnick & Fidell 2001). Outliers can be either problematic or beneficial. From a positive point of view, beneficial outliers could be indications of characteristics of the population that would not be discovered from normal analysis. On the contrary, problematic outliers do not represent the population and can seriously distort the analysis. Therefore, the outlier analysis not only checks for the presence of outliers in the data but also the direction of the influence, whether harmful or helpful. Outliers can be detected at three levels: the univariate, bivariate and multivariate levels.

Univariate outliers are cases that have an unusual value for a single variable (Tabachnick & Fidell 2001). Hence, the univariate method examines all metric variables to identify unique or extreme observations. This involves visually examination of histograms, Q-Q plots or by using standard cores. Those cases that fall at the outer ranges (either low or high) of the distributions are potential outliers. The current research involves 179 samples. The outliers were defined as cases with a standard score of the tested variable, which was calculated by dividing each individual raw score of the variable by the sample standard deviation, of 2.5 or greater (Hair et al. 2010). This method is simple to conduct; however, each variable is measured separately. To avoid bias from the situation whereby observations may occur normally in the outer ranges of the distribution, only those truly distinctive observations are designated as outliers. For each univariate test on a variable, the outlier cases are recorded and compared with outlier cases identified from the univariate test on the other variables. From this univariate perspective, among 77 variables of the study, 26 cases exceeded the threshold on two or more variables. However, none of these cases had values so extreme as to affect any of the overall measures of the variable, such as the mean or the standard deviation. Therefore, instead of being deleted, these cases were noted in the assessment with the multivariate method.

The bivariate method uses scatter plots to pair variables. Cases that fall distinctively outside the range of the other observations will be seen as isolated points on the scatter plots. However, since there are a total of 77 variables in the current study, the number of scatter plots required is 2,926, which is difficult to analyse. Therefore, the bivariate method was not used in this study.

The multivariate method appears to be the most useful and relevant of all available methods. It overcomes the problems of the univariate and bivariate methods by assessing a multidimensional position of each observation instead of only one dimension (variable) at a time (with the univariate method) or two dimensions at a time (with the bivariate method). Multivariate outlier detection is conducted by measuring the D2/df, which is distributed as a t-value (Hair et al. 2010; Tabachnick & Fidell 2001). D2 is known as the Mahalanobis distance and is the distance between each observation in multidimensional space from the mean centre of all the observations (known as the centroid). Df is the degree of freedom, or the number of variables involved (Hair et al 2010). There is no strict recommendation for a threshold level for the D2/df measure. However, Hair et al. (2010) suggest that it should be a conservative level of significance (0.005 or 0.001) resulting in a value of 2.5 for a small sample size (80 or fewer observations) or 3 or 4 in a large sample size. Setting a low threshold could result in the deletion of too many cases, and consequently could case bias or data wastage. Too high a threshold could lead to some outliers not being identified, hence distorting the results. The current research has 179 cases, and thus the stringent threshold value of 2.5 was used. The analysis did not detect any case as a multivariate outlier. The 26 cases that were detected to be outliers using the univariate detection method were not outliers under the multivariate method. As a result, no case was deleted and the sample size remained 179 cases.

5.5 TESTING FOR ASSUMPTIONS OF MULTIVARIATE ANALYSIS

The earlier step of data preparation and cleaning provided the data in a format and quality suitable for mutivariate analysis. However, in order to use multivariate analysis techniques for further data analysis, the data needed to be tested to determine whether they complied with the statistical assumptions underlying multivariate techniques. If the data do not satisfy these assumptions, the statistical results will not be a precise reflection of reality. Further requirements to test statistical assumptions in multivariate analysis are due to two reasons. First, the complexity of the relationships due to the typical use of a large number of variables makes the potential for distortions and biases more likely when these assumptions are violated (Hair et al. 2010). Second, it becomes more difficult to signify the indicators of assumption violations in a complex relationship (Hair et al. 2010). Therefore, the four most important tests for the assumptions of multivariate analysis, multivariate normality, homoscedasticity of variances, linearity, and multicollinearity were considered essential and will be presented in the next section.

5.5.1 Testing for Normality

Normality refers to the normal distribution of variables. This is the most fundamental assumption in multivariate analysis because if this assumption is violated, certain statistical tests are either invalid or not applicable (Hair et al. 2010; Tabachnick & Fidell 2001). Multivariate analysis requires multivariate normality assumption. It is a condition whereby the both the individual variables are normally distributed and the combinations of these variables are normally distributed. The normal distribution has the form of a bell-shaped curve and the standard normal distribution has a mean of 0 and a standard deviation of 1. The violation of normality assumption can be viewed in two dimensions: the shape of the distribution and the sample size.

Kurtosis and skewness are the two dimensions that describe the shape of a distribution. Kurtosis refers to the ‘peakiness’ or height of a distribution. A positive kurtosis indicates a higher peak than the normal distribution while a negative kurtosis indicates that the distribution is flatter than the normal distribution (DeCarlo 1997). Skewness describes the symmetrical balance of the distribution. Skewness can either be negative (the distribution is unbalanced and shifted to the right) or positive (the distribution is unbalanced and shifted to the left). Departure from normality in terms of kurtosis and skewness indicates a violation of the assumption of normality. However, the impact of violation is also dependent on the sample size. In a small sample, significant departures from normality can have greater impact whereas in a larger sample size of 200 or more the same impact may be negligible (Hair et al. 2010).

Analysis of normality can be conducted visually by assessing the normal probability plot, or more commonly, through statistical tests of kurtosis and skewness. In the former method, the normal distribution forms a straight diagonal line, and the line presenting the actual data distribution is compared with the diagonal. If the line follows the diagonal, the distribution of data is normal. Any departure from a normal distribution would result in a deviation of the line from the diagonal. The latter method measures the statistical value for the skewness and kurtosis values, which are named z-skewness and z-kurtosis respectively. As a rule of thumb, values for skewness and kurtosis divided by the standard error should be should be within +1.96 and -1.96 for the desired corresponding 0.05 error level, or more linearly, within -2.58 and +2.58 for the desired 0.01 error level for normally distributed variables (Hair et al. 2010). The more lenient -3 to +3 range is also widely used in the literature (Tabachnick & Fidell 2001). The current research employed the statistical test of normality. The results of the normality test are displayed in Table 5.5

Table 5.5 Results of Normal Distribution Tests

Variable	Mean	Std. Dev.	Z-skew	Z-kurt	Comment	Variable	Mean	Std. Dev.	Z-skew	Z-kurt	Comment
ED1	2.91	1.188	-0.433	-2.426		ESS1	3.36	1.048	-1.971	-1.098	
ED2	2.91	1.09	-0.257	-1.404		ESS2	3.09	0.976	-0.452	-1.006	
ED3	3.1	1.039	-0.451	-0.543		ESS3	3.44	1.122	-1.898	-2.093	
ED4	3.01	1.041	-0.893	-0.05		ESS4	3.39	1.007	-2.204	-1.352	
ESHM1	3.25	1.063	-1.224	-1.891		ESS5	3.5	1.057	**-3.221**	-0.875	Neg.
ESHM2	4.17	0.797	**-4.681**	1.358	Neg.	ESS6	3.2	1.076	-0.233	-1.915	
ESHM3	3.75	0.886	**-3.097**	0.437	Neg.	ESS7	3.01	1.033	-0.465	-1.35	
ESHM4	3.88	0.913	**-4.861**	2.067	Neg.	EST1	3.29	1.197	-1.544	-2.157	
ESHM5	3.61	1.098	**-3.333**	-0.633	Neg.	EST2	3.49	1.173	**-3.503**	-1.09	Neg.
ESHM6	3.87	0.918	**-4.155**	0.818	Neg.	EST3	3.15	1.097	-1.325	-1.703	
ESHM7	3.56	0.881	-1.502	-1.083		EST4	3.14	1.253	-0.9	-2.851	
ESHM8	3.49	1.103	**-3.576**	-0.63	Neg.	EST5	2.76	1.103	0.038	-2.227	
ESHM9	3.13	1.098	-0.917	-2.088		EST6	2.76	1.088	-0.503	-2.297	
ESHM10	4.13	0.742	**-3.917**	1.602	Neg.	EST7	2.8	1.2	0.265	-2.58	
ESHM11	3.86	0.993	**-4.77**	1.336	Neg.	EST8	3.08	1.111	-1.331	-1.826	
ESHM12	3.33	1.081	-1.168	-1.884		OA1	15.8	5.593	-2.11	-0.966	
ESHM13	3.68	0.963	**-3.537**	0.194	Neg.	OA2	16.15	5.545	-1.429	-0.714	
ESR1	3.31	0.848	-1.347	1.838		OA3	13.26	5.564	0.716	-1.264	
ESR2	3.49	0.857	-2.092	1.116		OA4	14.19	5.696	-0.12	-1.774	
ESR3	3.3	1.042	-1.586	-1.329		OA5	10.94	5.127	1.86	-0.105	

ESR4	2.91	0.901	-1.073	-0.008		OA6	10.19	5.139	**3.874**	1.453	Pos.
ESR5	3.22	0.939	-0.955	-0.325		OA7	10.87	5.098	**3.22**	0.687	Pos.
ESR6	2.97	1.005	-0.367	-1.113		OA8	11.8	5.69	2.659	-0.853	Pos.
ESR7	3.65	0.927	**-4.556**	2.106	Neg.	OA9	10.6	5.065	**5.082**	2.654	Pos.
ESR8	3.42	1.027	**-3.296**	-0.236	Neg.	OA10	11.42	5.14	**3.679**	0.339	Pos.
ESR9	3.11	0.886	-1.219	0.936		OA11	10.92	4.93	**4.033**	2.014	Pos
ESR10	3.41	0.963	**-3.894**	1.013	Neg.	ES_FS	.935	.135	**-15.08**	**24.17**	Pos
						EOU	3.05	0.776	-1.12	-0.053	
Neg.: Negatively skewed											
Pos.: Positively skewed											

As shown in Table 5.5, out of the total of 55 variables, there were 20 that had z-skewness scores that fell beyond the range of -3 to +3, hence they are not normally distributed. All variables met the proposed level of -3 to +3 for kurtosis. There were 14 variables that were negatively skewed and six that were positively skewed. Although data transformation is one remedy to convert the data to a normal distribution, since any transformation method for normality must be conducted on all variables, adjustment to a skewed variable will cause further violations to the other variables that are skewed in the opposite direction. For example, a transformation of the negatively skewed variables is to reverse, or reflect, the value so that the distribution becomes positively skewed. Reflection is computed by subtracting all of the values for the variable from 1 plus the absolute value of the maximum value for the variable. This transformation results in a positively skewed distribution with all values greater than 0. However, the reflection method causes the distribution of positively skewed variables to move further away from the normally distribution position. Moreover, variables are still highly skewed or highly kurtotic even after transformation (Tabachnick & Fidell 2001). Therefore, no transformations were used as a remedy for normality transformation in this study.

5.5.2 Testing for Homoscedasticity

The test for homoscedasticity involves checking if the variance of the dependent variable being explained in a dependence relationship exhibits a similar size across the range of predictor variable(s) rather than being concentrated in only a limited range of the independent variables (Hair et al. 2010). To conduct the homoscedasticity test, which is also known as the test for homogeneity of variance, the variance of the dependent variable values are compared at each value of the independent variable. If the variance values are relatively equal, it indicates that the dependence relationship between the dependent variable and the independent variable exists. The two most common sources of heteroscedasticity are the variable type and a skewed distribution of one or both variables. When the assumption of multivariate normality is met, the relationships between variables are homoscedastic, thus, homoscedasticity is strongly related to the assumption of a normal distribution (Tabachnick & Fidell 2001). Homoscedasticity is evaluated for pairs of variables and can be conducted through either graphical or statistical methods. This research applied a graphical method. The examination of homoscedasticity showed certain violations of homoscedasticity with some independent-dependent scatter plots. Hence, the assumption for homoscesdasticity is violated. Some examples of the homoscedasticity test are presented in the Appendix 5.2. Transformation can be applied to one or more variables to make them more homoscedastic (Hair et al. 2010). However, similar to the reasoning of violation for normality, no transformations to the variables were applied in this research.

5.5.3 Testing for Linearity

Multivariate analysis works on the assumption that the causal relationship between independent and dependent variable is linear (Hair et al. 2010). Linearity refers to a consistent slope of change that represents the relationship between the independent variable and the dependent variable. If a relationship is nonlinear, the statistics which assume it is linear will not only underestimate the strength of the relationship but also cause inaccurate predictions, especially when the result is generalised beyond the range of the sample. The test for linearity is achieved through either graphical or statistical method (Tabachnick & Fidell 2001). With the graphical method, the scatter plot of the observed versus the predicted values or a plot of residuals versus predicted values is analysed. The point should be symmetrically distributed around the diagonal line in the former plot and the horizontal line in the latter plot. With the statistical method, the hypothesis test for linearity is tested. The relationship is linear if the difference between the linear correlation coefficient and the nonlinear correlation coefficient is small. Both methods were used in the current research. Assessment of the scatter plots for each pair of independent and dependent variable did not reveal any nonlinear relationships. The statistical test for linearity is conducted by analysing the correlation matrices for the dependent variables and the independent variables. If the correlation coefficient between an independent variable and a dependent variable is not statistically significant ($p>0.05$), the relationship is linear. The deviation for linearity test available in the ANOVA test in SPSS indicated that all the significant values for deviation from linearity were greater than 0.05 (see Appendix 5.3). Therefore, the assumption of linearity in the data in this study is valid.

5.5.4 Testing for Multicollinearity

Multicollinearity exists when two or more independent variables are highly correlated (Hair et al. 2010). This situation happens when the independent variables measure the same thing, which results in redundant measures. Although items that measure the same construct must be correlated, correlations higher than 0.9 between any item can cause statistical problems (Tabachnick & Fidell 2001). Multicollinearity causes both logical and statistical problems. The logical problem is that redundant variables are included while they are not needed in the same analysis. The statistical problem is that the test for multicollinearity is conducted by assessing the item-item correlation matrix (refer to Appendix 5.4) to identify any substantially high multicollinearity. No multicollinear item was identified.

In summary, the tests of the assumptions necessary for multivariate analysis revealed few violations. The normality analysis identified that 20 of the 55 variables violated this assumption. There are four options to deal with the non-normality problem. The first option is to leave the data as it is (non-normal) and conduct parametric tests with the assumption of normality. Since normality represents a degree rather than a strict threshold for multivariate analysis, slight deviations from normality may result in slight inaccuracies in parametric tests (Hair et al. 2010). The second option is to conduct non-parametric tests designed for non-normal data, even though non-parametric tests can be considered less powerful when compared with parametric tests (Siegel 1957). The third option is to transform the data by using mathematical formulae into normality (Hartwig & Dearing 1979). The fourth option is to conduct 'robust' tests. These tests are just as powerful as parametric tests but account for non-normality in the data (Chin et al. 2003; Hair et al. 2010, 2011).

This study chose to use the fourth option and apply variance-based structural equation modelling, such as PLS, as the analytical method to investigate the relationships between the constructs in the model. While different from the covariance-based SEM (CBSEM) such as LISREL and AMOS, the variance-based SEM that was in this study provides a relevant data analysis technique. The limitation of a small sample size (179 observations) can be overcome by using PLS since the statistical power of PLS is always equal to or larger than that of CBSEM (Hair et al. 2011; Reinartz et al. 2009). The focus of CBSEM is estimating a set of model parameters so that the theoretical covariance matrix implied by the system of structural equations is as close as possible to the empirical covariance matrix observed within the estimation sample (Reinartz et al. 2009, p. 332). This estimation requires the assumption that the data are normally distributed. Instead, PLS estimates the model parameters to maximise the variance explained for all endogenous constructs. It does not require any distribution assumption and goodness-of-fit statistics (Vinzi et al. 2010). Further discussion on the application of PLS as the analytic method in this study will be presented later.

5.6 TESTS FOR GENERALISABILITY

To ensure that it is possible to generalise the research findings from the sample to the population, several tests for generalisability of the data were conducted. They test for bias due to the data being collected in different locations (Australia and New Zealand) and also for non-response bias. These tests are presented in the next section.

5.6.1 Sample Bias Test for Geographical Location

The data were collected in both Australia and New Zealand. These two countries are closely related geographically and are relatively similar in terms of their history and development, which leads to similar business environments. However, testing for non-bias in term of geographical location was required to ensure the reliability of the research findings. The sample was segregated into two subsamples, with one each representing Australia and New Zealand respectively. The Australian subsample had 158 cases (88.3 per cent) while the New Zealand subsample had 21 cases (11.7 per cent). The two samples independent t-test at the 5 per cent significance level was used to compare the two subsamples. The result of the test on the mean score of the construct is displayed in Table 5.6. The full result on all variables is provided in Appendix 5.5.

Table 5.6 Independent Sample T-tests for Geographical Bias in the Sample Location

	F	Sig.	Mean AU	Mean NZ	Mean Difference	Std. Error Difference	T	Sig. (2-tailed)
Mean OA	0.085	0.770	12.3285	12.7273	-0.39873	0.82923	-0.481	**0.631**
Mean ESS	0.408	0.524	3.2541	3.5034	-0.24933	0.19326	-1.290	**0.199**
Mean ESR	0.771	0.381	3.2582	3.4286	-0.17034	0.15569	-1.094	**0.275**
Mean EST	3.539	0.062	3.0333	3.2560	-0.22261	0.20717	-1.075	**0.284**
Mean ESHM	1.542	0.216	3.6513	3.8132	-0.16187	0.13532	-1.196	**0.233**
Mean ED	1.734	0.190	3.0063	2.9524	0.05395	0.20025	0.269	**0.788**
Mean ESF	1.626	0.204	3.1363	3.3280	-0.19166	0.16674	-1.150	**0.252**

The result of the independent sample t-test to check for geographical bias showed that the difference between the Australian and New Zealand responses were not statistically significant at the 95 per cent confidence interval and therefore that the data could be combined.

5.6.2 Non-response Bias Test

Non-response is an inevitable issue when conducting survey research. It occurs when some of the targeted participants do not return the questionnaire. Non-response may cause sample bias because the answers of respondents may differ from the potential answers of those who did not response (Dillman 2000). As the result, non-response bias results in low accuracy of estimations when the research findings are generalised to the population. The survey response rates in most Western countries have declined during recent decades (Lahaut et al. 2002). The current research had a response rate of 22.7 per cent, which resulted in a small final sample size of 179 cases. Therefore, it was essential to conduct the non-response bias test in the current research (Armstrong & Overton 1977). One widely used method for testing non-response bias is to compare the data of those that responded early to those who respond late after follow-up letters are sent (Armstrong & Overton 1977). Those respondents who respond to the questionnaire later are assumed to have similar characteristics to those who do not reply. Therefore, comparing the characteristics of early respondents to those of late respondents will reveal if non-response bias exists (Armstrong & Overton 1977). There is no accepted norm regarding the characteristics that can be used to compare the early and late respondents. However, the literature suggests that early respondents are more interested in the research and thus are more willing to participate and return the survey early (Armstrong & Overton 1977; Korkeila et al. 2001).

Each returned questionnaire was recorded with the date it was received. The sample was divided into two subsamples by using the initial closing date of the survey. The first subsample contained 118 responses (65.9 per cent) while the second subgroup contained 61 responses (34.1 per cent). The two samples independent t-test at the 5 per cent significance level was used to compare the two subsamples. The result of the test on the mean score of the construct is displayed in Table 5.7, while the results of the test on all variables are presented in Appendix 5.6.

Table 5.7 Independent Sample T-test for Non-response Bias

	F	Sig.	Late Resp.	Early Resp.	Mean Diff.	Std. Error Diff.	T	Sig. (2-tailed)
Mean OA	3.177	0.076	12.4441	12.3398	0.10436	0.56331	0.185	**0.853**
Mean ESS	3.392	0.067	3.1686	3.3426	-0.17400	0.13118	-1.326	**0.186**
Mean ESR	0.359	0.550	3.2803	3.2771	0.00321	0.10606	.030	**0.976**
Mean EST	0.087	0.769	2.8996	3.1421	-0.24251	0.13993	-1.733	**0.085**
Mean ESHM	0.106	0.745	3.6759	3.6674	0.00851	0.09224	0.092	**0.927**
Mean ED	0.124	0.725	2.8648	3.0699	-0.20516	0.13511	-1.518	**0.131**
Mean ESF	0.997	0.319	3.2647	3.1041	0.16057	0.11298	1.421	**0.157**

The result of the independent samples t-test to check for non-response bias did not identify any significant difference between the means of the two subgroups at the 95 per cent confidence interval. The result shows that even if non-response bias cannot be completely ruled out, it is not statistically significant and thus should not cause major problems for generalisability.

5.6.3 Common Method Bias

Common method bias may occur in data that were collected via the same instrument or at only one point in time (Straub et al. 2004). When common method bias occurs, the variance is attributed to the measurement method rather than to the related research model or any other causal relationship (Podsakoff et al. 2003; Spector 1987). The method variance causes a systematic measurement error and either inflates or deflates the observed relationships between the theoretical constructs (Podsakoff et al. 2003). Among several methods to test for common method bias, the current research employs Harman's single factor test, which is the most widely used test reported in the literature (Podsakoff et al. 2003). This method examines the unrotated factor solution of all 55 variables in an exploratory factor analysis. If there is a substantial amount of common method variance then (1) a single factor will emerge from the factor analysis, or (2) one general factor will account for the majority (50 per cent) of covariance among the variables (Greene & Organ 1973; Podsakoff et al. 2003).

An exploratory factor analysis was conducted to examine the possibility of common method bias in this study under the conditions that the number of factors was extracted to 1, and no rotation method was used. The results showed that one general factor accounts for 29.7 per cent of the total variance (see Appendix 5.7). This number indicates a substantial amount of variance is explained by a single factor; however, it does not account for the majority (greater than 50 per cent). The test found no significant bias in the dataset due to the research method. In summary, the tests for the generalisability of the data and for common method bias suggest that there is no significant bias.

5.7 SUMMARY

The objective of this chapter was to prepare data for final analysis. For that purpose, the data collected in the survey went through a systematic process of screening and cleaning that consisted of testing the data for missing values, outliers, departure from normality, homoscedasticity, linearity, multicollinearity, geographical bias, non-response bias, and common method bias. Data that failed these tests were considered for deletion or amendment. The summary of test results, the remedial actions as well as the changes to the data after each of the data preparation stages is presented in the Table 5.1. The test for normality revealed that 22 out of the total 55 variables of the model violated the requirement for multivariate normality. Hence, the study used PLS as the analytic method instead of other CBSEM methods such as AMOS or LISREL which do not require data to be normally distributed. A total of 45 cases were deleted after the data screening and cleaning procedures presented above, which leaves a final sample size consisting of the data from 179 respondents.

CHAPTER 6: DATA ANALYSIS—MEASUREMENT MODEL VALIDITY

6.1 INTRODUCTION

The previous chapter described the data screening and preliminary analysis procedures applied to the collected data. This process excluded data from organisations outside the sample frame (e.g., responses from organisations whose main operations are not in the industries the survey aimed to address), and tested the remaining data for missing data, outliers, non-response bias, and normality. Further appropriate treatments were applied to rectify missing data. The next two chapters continue with the data analysis, with two distinct steps of the model building approach proposed in SEM and the related literature (Anderson & Gerbing 1988; Hair et al. 2010; Schumacker & Lomax 2004). Step 1 involved measurement refinement and initial analysis by assessing the validity and reliability of the measurement model. The second step involved building and testing the structural model validity (Hair et al. 2010). The extent to which the collected data are an accurate representation of the theorised latent constructs was characterised as per the rigour of the research design (Straub et al. 2004). The assessment of the validity of the measurement model is presented in this chapter and the structural model validity will be presented in the next chapter (Chapter 7).

An overall research model cannot be tested unless the measurement properties of its constructs are found to be reliable and valid. The two dimensions necessary for assessing the measurement model are the validity and reliability of the constructs. Reliability measures the extent to which the instrument is reliable in measuring the same results on repeated occasions (Straub et al. 2004). Validity checks if the instrument is measuring what it is supposed to measure (Schwab 1980). The assessment of measurement model reliability is conducted by internal consistency reliability in two phases: (1) initially for purifying the measurement scales, and (2) later after the items have been tested for their validity (Straub et al. 2004). Measurement model validity tests involve content validity, factorial validity, construct validity (consisting of convergent and discriminant validity) and nomological validity. These tests are conducted by using factorial analysis consisting of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA is used to identify, reduce and validate the underlying factors of the construct (Anderson & Gerbing 1988). CFA is used to confirm and reduce the number of factors from the remaining construct. SPSS software was used to perform the EFA while SmartPLS software was used to conduct the CFA (Falk & Miller 1992; Ringle et al 2005).

The following sections present the validity and reliability tests of the measurement model. Section 6.2 reports the initial construct reliability test to ensure that the prerequisite conditions for the construct validity of the research instrument discussed in subsequent sections were met. Section 6.3 presents the validity tests of the measurement model, which include content validity, factorial validity, convergent validity, discriminant validity and nomological validity. Next, in Section 6.4, the final reliability test ensured the rigorousness of the measurement model. A brief summary is presented in Section 6.5.

6.2 INITIAL RELIABILITY AND MEASUREMENT PURIFICATION

Although a clearly defined item development process has provided a pool of items that theoretically should operationalise the constructs, measurement purification is recommended before testing the construct validity (Reardon et al. 1995). To increase the accuracy of measurement and ensure that measures that should be related to each other within the same construct are indeed related to each other, the initial reliability is tested before the construct validity. Without reliable measures, it is difficult to see how the data can be trusted (Straub et al. 2004).

Internal consistency measures a construct through a variety of items within the same instrumentation. If the scores from each of the items correspond highly with each other, the construct can be said to demonstrate acceptable reliability (Straub et al. 2004). Internal consistency can be assessed through two statistical indicators; item-total correlation and Cronbach’s alpha. These two statistics examine if any item in the set is inconsistent with the average behaviour of the other items, and thus can be discarded. The item-total correlation, on the other hand, indicates if a single item is reliable in representing the construct. Low correlation between items indicates that the items do not represent the same construct. A correlation value less than 0.3 indicates that the corresponding item does not correlate very well with the scale overall and thus may be dropped (Hair et al. 2010). High values (>0.95), however, are suspect as they indicate multicollinearity and the possibility that respondents have not answered objectively (Straub et al. 2004; Tabachnick & Fidell 2001).

Cronbach's alpha is a widely used index of internal consistency reliability (Streiner 2003). Values of Cronbach's alpha range from 0 to 1, with higher values indicate greater reliability (Straub et al. 2004). Cronbach's alpha is dependent on the number of items and the mean of the correlation coefficients between two items (Straub et al. 2004). It indicates if the items as a whole represent the construct. The 'Cronbach's alpha if item deleted' presents the hypothetical Cronbach's alpha coefficients that would be obtained if each item were deleted. Hence, by examining the results, a researcher can immediately determine whether deleting a particular item would increase or decrease overall reliability. Actions based on the 'Cronbach's alpha if item deleted' improves the construct reliability in two aspects (Dörnyei & Taguchi 2010). First, it helps to improve the overall reliability of a construct by identifying and then deleting items that reduce the construct's Cronbach alpha. Second, it helps to reduce the number of items in a large-scale construct by deleting those items whose absence do not cause a theoretical gap in the content of the scale and whose deletion will not bring the scale's Cronbach alpha coefficient below the minimal threshold of 0.7 (0.6 with exploratory constructs) (Straub et al. 2004).

The item-total correlations and Cronbach's alpha were calculated for each construct separately. Appendix 6.1 illustrates the items, their item-total correlation coefficients (known as item scale), the Cronbach's alpha if item deleted and the Cronbach's alpha values of the constructs. The item-total correlation value of each item to its designated construct is greater than the cut-off value of 0.3. This indicates that each item has strong internal consistency with other items of the construct. The Cronbach's alpha values of the constructs are all greater than 0.7, except the construct ES functional competence (ESF). However, ESF is a new construct that has not been developed in the literature and the Cronbach's alpha of this construct is 0.624, which surpasses the threshold of 0.6 for exploratory constructs (Nunnally 1978). For the rest of the constructs and their respective items, the value of the relevant Cronbach's alpha would be reduced if the item were deleted from the scale. Therefore, the research instrument remains at 55 variables from seven constructs.

6.3 ASSESSING MEASUREMENT VALIDITY

The measurement model validity tests involved (a) content validity, (b) factorial validity, and (c) construct validity (consisting of convergent and discriminant validity (Straub et al. 2004).

6.3.1 Content Validity

Content validity is concerned with the question of whether or not the instrumentation operates in a representative manner from all of the possible ways that could be used to measure the content of a given construct (Straub et al. 2004; Lewis et al. 2005). Some of the pragmatic methods to measure content validity were identified through literature reviews and expert opinion (Straub et al. 2004). A comprehensive review of literature as well as several rounds of pre-testing the study instrument with different groups of experts increases the accuracy of instrumentation in representing the constructs. Content validity in this study was ensured through the process of reviewing literature as described in Chapter 2, designing the conceptual framework outlined in Chapter 3 based on pre-existing relationships between constructs that were identified in Chapter 2 and developing the items from the existing framework. The items were later assessed by the panel of experts and pilot tested as outlined in Section 4.4.3, Chapter 4. These processes of instrument development ensure sufficient content validity of the constructs.

6.3.2 Factorial Validity

Unlike exploratory CFA of covariance-based SEM methods, PLS cannot test the underlying dimensionality of the data. Instead, this must be has to be assumed a priori on latent variables. However, unidimensionality, which specifies that a set of measures represent only a single construct, is a fundamental requirement for good psychometric measures (Anderson & Gerbing 1988; Straub et al. 2004). Therefore, in order to account for the unidimensionality condition, an EFA was conducted to identify the structure of the measurement model.

Factorial validity is concerned with unidimensionality. The latent constructs are measured by one or more variables. Factorial validity identifies if the underlying structure among the variables extracted from the data are consistent with those proposed by the framework. The purpose of factorial validity is to examine the construct independent of its theoretical connections to ensure that the variables are sufficiently intercorrelated to produce representative factors (Straub et al. 2004).

There are two possible methods to measure factorial validity; multi-trait multi-method matrix (MTMM) or factor analysis (Campbell & Fiske 1959). MTMM seems to be the preferred technique within the field when more than one research method is used, whereas factor analysis appears to be the more commonly used technique when a single method is employed (Straub et al. 2004). In the current study, because a single method is used, factorial validity was established through EFA, which can be used to derive the initial set of factors for the construct (Lewis et al. 2005).

An important concern in EFA is sample adequacy. Hair et al. (2010) suggested a case-to-variable ratio of 5:1 to guarantee a reliable EFA procedure. The measurement model contains a total of 55 variables with sample size of 179. The variable-to-sample size ratio is less than 5:1. However, this research works with four distinct theoretical domains of ESC, ES-enabled capabilities, OA and ED, tapping into organisational resources, organisational capability, organisational performance and market context, respectively. Therefore four separate EFA models were run and each model satisfied the sample adequacy criterion.

The applicability of using EFA was verified through visual analysis of correlation, Barlett's test, and the Kaiser-Meyer-Olkin (KMO) test (Hair et al. 2010). The results of these tests are summarised in Table 6.1. First, visual inspection of the correlations revealed a substantial number of correlations greater than 0.30 for all constructs. Second, the Bartlett's sphericity test, which provides evidence that the correlation matrix has significant correlations among at least some of the variables and the original correlation matrix is an identity matrix, indicated that the correlation matrix generated from the data was different from the identity matrix. Third, the KMO test indicated the partial correlations in comparison to the sum of correlations with an acceptable value of 0.5 or greater (Hair et al. 2010).

In running the EFA, principal component analysis, the VARIMAX rotation method, and a minimum eigenvalue of 1 were chosen as conditions for factor extraction. Items were allocated to a factor if their primary loading was greater than 0.5, if they did not crossload onto more than one factor and if their communality is greater than 0.4 (Lewis et al. 2005). The threshold of item primary loading for EFA used in IS studies is 0.5 (Lewis et al. 2005). Items that have loadings below the threshold should be dropped from further analysis. The applicability of using EFA was verified through several criteria (see Table 6.1).

Table 6.1 Summary of the Factor Analysis Applicability Criteria

	Requirement (Hair et al. 2010)	Research Constructs				
		ESC	OA-enabled ES Capabilities	OA	ED	Requirement Met (Y/N)
Case-to-variable ratio	>5:1	7.46:1	10.53:1	16.27:1	44.75:1	Y
Visual analysis of correlation	>0.30	>0.3	>0.3	>0.3	>0.3	Y
Barlett's test (sig.)	0	0	0	0	0	Y
KMO	>0.50	0.854	0.904	0.844	0.753	Y
Eigenvalues included	>1	>1	>1	>1	>1	Y
Percentage of variance	>60 per cent	65.457	60.087	69.145	63.773	Y
Number of factors extracted		5	2	3	1	

The iterative sequence of factor analysis and item deletion was repeated whenever an item was dropped from the analysis of each of the four concepts: OA, ES-enabled capabilities, ESC, and ED. The results of the EFA (see Appendix 6.2) indicate that there were a total of 11 factors and the factor patterns were as expected for all constructs, with most items loading highly on their theorised factor.

Using the iterative sequence of factor analysis, one item (ESR8, '*Create a high degree of intra-organisational business process interconnectivity)* was deleted from the ES-enabled capabilities category because of its high cross-loading. Two items, ESHM9 '*Organisational resources (financial, leadership, etc) can be easily mobilised when there is a need to change ES*' and ESHM10 '*Our IT staff can work cooperatively in cross-functional teams with personnel from other departments*' were deleted from construct ESHM due to their low loading (<0.5). After eliminating these items, the factor analysis resulted in a final instrument of 52 items representing 11 factors.

The factor structure of OA produced three subdimensions. Following Hair et al.'s (2010) recommendation on labelling the factors based on their appropriateness for representing the underlying dimensions of the factors and names of the variables with higher loadings, these three factors were named 'customer agility', 'operational agility' and 'partnering agility'.

Customer agility refers to the ability to explore and exploit the customer relationship in order to gain market intelligence and detect competitive action opportunities (Sambamurthy et al. 2003). It consists of items OA1 '*Constantly look for opportunities to add value to our customers*', OA2 '*Quickly respond to customers' needs'* and OA3 '*Continuously anticipate our customers' needs*'. Operational agility is defined as the ability to accomplish speed, accuracy, and cost economy in the exploitation of opportunities (Sambamurthy et al. 2003).

Operational agility is reflected through five items: OA4 '*Quickly adapt to changes from the market (i.e., regulation changes, technological innovations, cultural shifts, competitors' actions, etc)*', OA5 '*Quickly shorten the time-to-market of new products and/or services'*, OA6 '*Easily redesign existing business processes*', OA7 '*Easily create new business processes*' and OA8 '*Easily launch new products/services*'. Partnering agility indicates the ability to leverage a business partner's knowledge, competencies, and assets (Sambamurthy et al. 2003). Thus, it is measured by three indicators: OA9 '*Easily switch between* *suppliers*', OA10 '*Easily establish new supply chain partnerships*' and OA11 '*Easily change the type of resources that we acquire from our suppliers*'.

As expected and as theorised, the factor model for ES-enabled capabilities identified two subdomains; ESS and ESR. However, three items (ESR7 '*Increase the accuracy of information used by top management in making strategic decisions'*, ESR9 '*Generate new business strategies*', ESR10 '*Empower end users for taking actions in business operation*s') that were expected to measure ESR loaded to ESSC. These three items measure management capability at the strategic level and it appears that respondents may have perceived these items and related their influence to the sensing process. Acoordingly, for the subsequent analysis, these three items were included within the ESS variable.

The factor model for ESC consisted of five subfactors named ES technical competence (EST), ES human competence (ESH), ES vendor competence (ESV), ES management competence (ESM), and ESF. ESH refers to the competence of the IT staff that have both the technical and business knowledge to manage the ES and transfer that knowledge to end users. ESV refers to the competence of ES vendor(s) that can troubleshoot problems and provide continuous support to organisations. ESM refers to the competence of the strategic level management of ES that aligns ES development strategy with business objectives. ESF refers to the extent of ES functionality in support to business processes. Finally, the factor ED was maintained as theorised. Table 6.2 summarises the overall results of the factor analysis exercise.

Table 6.2 Summary of Factor Analysis

Construct	Factor	Items	Number of items	Cronbach's alpha
OA	Customer Agility (OA_C)	OA1, OA2, OA3	3	0.809
	Operational Agility (OA_O)	OA4, OA5, OA6, OA7, OA8	5	0.838
	Partnering Agility (OA_P)	OA9, OA10, OA11	3	0.816
ESS Capability	ESS	ESS1, ESS2, ESS3, ESS4, ESS5, ESS6, ESS7, ESR7, ESR9, ESR10	10	0.918
ESR Capability	ESR	ESR1, ESR2, ESR3, ESR4, ESR5, ESR6	6	0.845
ESC	EST	EST1, EST2, EST3, EST4, EST5, EST6, EST7, EST8	8	0.904
	ESH	ESHM2. ESHM4, ESHM5, ESHM6, ESHM7	5	0.816
	ESV	ESHM3, ESHM8	2	0.656
	ESM	ESHM11, ESHM12, ESHM13	3	0.817
	ESF	ES_FS, EOU	2	0.624
ED	ED	ED1, ED2, ED3, ED4	4	0.806

The variables ESV and ESF have Cronbach's alpha values of 0.656 and 0.624 respectively, which still surpasses the threshold of 0.6 for exploratory constructs. Since ESF and ESV are new constructs that have not been developed in the literature, they were retained in the model and the study.

Furthermore, upon checking reliability, the item ESHM1 '*Our end users (business managers, business staff) are sufficiently skilled to effectively use ES*' was dropped due to low item reliability. First, the squared multiple correlation, which indicates how much of the variability in the response to this item can be predicted from the other items, was 0.149 which is less than the minimum requirement of 0.3. Second, the Cronbach's alpha if item deleted (0.690) was higher than the alpha value with the item included (0.656). Therefore, ESV consists of only two items: ESHM3 and ESHM8.

6.3.3 Construct Validity

Construct validity is concerned with the question of whether the measures chosen by the research fit together in such a way so as to capture the essence of the construct (Straub et al. 2004). Construct validity focuses on the measurement of individual constructs. Two construct validities, convergent and discriminant, were tested by using PLS based on the factor loadings SMC and average variance extracted (AVE) using smartPLS (Falk & Miller 1992). For the measurement of the second and third order constructs the repeated indicators approach was used (Wold 1982). In essence, a second and third order factor is directly measured by observed variables for all the first order factors, meaning that all the observed variables are used twice (Jarvis et al. 2003).

To specify the PLS model for assessing construct validity, all 11 constructs were defined as reflective constructs because the indicators are interchangeable in the questionnaires and have a common theme (Petter et al. 2007). Constructs ESM, ESH and ESV are conceptually related since they indicates the knowledge, skill and management capability of the people involved in the ES operation. Therefore, a construct 'enterprise system human and managerial competence' (ESHM) was created as a second order construct consisting of three first order constructs: ESM, ESH and ESV. The construct ESC is a third order construct that consists of constructs competence EST, ESHM and ESF. Construct OA consists of three subconstructs: customer agility (OA_C), operational agility (OA_O) and partnering agility (OA_P). Higher order constructs in the research are defined as reflective constructs that represent a higher level of abstraction with arrows which indicates the direction of causality, pointing to its respective level lower order constructs.

According to the CFA rule of thumb (Hair et al. 2010), a unidimensional two-item construct is underidentified on its own. An overidentified CFA model may result when this construct is integrated into the overall measurement model. Although ESF and ESV consist of only two indicators, they are acceptable because they are the subconstruct of the high order construct ESC in the overall measurement model. For the measurement of the second order constructs and third order construct i.e., OA, ESHM and ESC the repeated indicators approach was used (Wold 1982). In essence, a second order factor is directly measured by observed variables for all the first order factors, meaning that all the observed variables are used twice (Jarvis et al. 2003). A third order factor is directly measured by observed variables for all the first and second order factors. The repeated indicators approach was used because it is the easiest to implement and it works best with equal numbers of indicator for each construct (Chin 2010). The EFA results demonstrated a relatively equal number of indicators per construct for the second order constructs OA and ESC.

The literature identifies two approaches to obtain measurement model results. The first approach is to draw all possible structural links among the constructs and set the inner weighting option using the factorial scheme. This method simply uses the correlations to establish the inner weight of the structural model while ignoring all the directionality of the arrows among the constructs. The second approach is to set the constructs in a particular structural model that has been hypothesised to obtain the measurement model results. The current research applied the second approach by obtaining the initial constructs.

6.3.3.1 Convergent validity

Convergent validity assesses if the indicators of a specific construct should converge or share a high proportion of variance in common (Straub et al. 2004). It is the extent to which each measure correlates with other measures of the same construct. A measure that correlates highly with other measures is designed to measure the same construct (Churchill 1979). Evidence of convergent validity of an indicator can be established if all factor loadings for the indicators measuring the same construct are statistically significant. AVE is commonly used to assess the convergent validity, and measures the amount of variance that a latent variable captures from its indicators (Fornell & Larcker 1981). Convergent validity is considered adequate when AVE is 0.5 or more. Other evidence of convergent validity is provided by the standard factor loading (SFL) which is significant at the 0.05 alpha protection level and expected to be >0.7. To measure the significance, the conventional method in PLS estimation is to apply bootstrapping (Chin 1998). The sample sets are recreated in order to obtain the estimation for each parameter in the PLS model. Each sample is obtained by sampling with replacements from the original dataset. The number of bootstraps must be at least 200 to obtain stable results. The current research conducted bootstrapping with a sample size of 1,000 and a case size of 179.

Convergent validity of the first order constructs

The information needed to assess convergent validity can be obtained from the output report of SmartPLS. Appendix 6.3 gives the t-values of the outer loadings of the indicators on their latent constructs through bootstrapping, and Appendix 6.4 shows the loadings and cross-loadings of the measurement model. Table 6.3 summarises the results of the convergent validity evaluation.

Table 6.3 Validity and Reliability Analysis of the First Order Measurement Model

Variable	Item	SFL	SMC	AVE	Construct Reliability	Cronbach's Alpha
OA_C	OA1	0.841	0.707	0.723	0.887	0.809
	OA2	0.840	0.706			
	OA3	0.870	0.756			
OA_O	OA7	0.830	0.689	0.612	0.887	0.840
	OA6	0.820	0.673			
	OA5	0.778	0.605			
	OA8	0.765	0.584			
	OA4	0.712	0.507			
OA_P	OA10	0.863	0.745	0.731	0.891	0.816
	OA11	0.853	0.728			
	OA9	0.849	0.720			
ESS	ESS3	0.843	0.710	0.577	0.931	0.918
	ESS5	0.815	0.665			
	ESS4	0.801	0.641			
	ESS7	0.776	0.602			
	ESR7	0.760	0.577			
	ESS1	0.752	0.566			
	ESS2	0.738	0.544			
	ESS6	0.722	0.521			
	ESR10	**0.690**	0.476			
	ESR9	**0.681**	0.463			
ESR	ESR4	0.836	0.699	0.576	0.890	0.852
	ESR5	0.780	0.609			
	ESR6	0.778	0.605			
	ESR3	0.766	0.586			
	ESR1	**0.693**	0.480			
	ESR2	**0.689**	0.475			
EST	EST5	0.810	0.656	0.601	0.923	0.905
	EST1	0.790	0.624			
	EST6	0.790	0.624			
	EST3	0.782	0.611			
	EST8	0.779	0.606			
	EST4	0.773	0.597			

	EST7	0.737	0.543			
	EST2	0.737	0.543			
ESH	ESHM4	0.811	0.657	0.581	0.873	0.818
	ESHM6	0.808	0.653			
	ESHM5	0.774	0.598			
	ESHM2	0.715	0.511			
	ESHM7	**0.696**	0.484			
ESM	ESHM13	0.905	0.818	0.734	0.892	0.820
	ESHM12	0.849	0.721			
	ESHM11	0.814	0.663			
ESV	ESHM8	0.906	0.820	0.768	0.868	0.701
	ESHM3	0.846	0.715			
ESF	EOU	0.988	0.976	0.660	0.783	0.624
	ES_FS	**0.586**	0.343			

Construct Reliability (0.6 or higher), AVE (0.5 or higher), SFL (0.5 or higher) SMC (threshold 0.3 or higher)

Before testing the validity of the construct, the indicator reliability is tested to ensure that the measurement variable is appropriate for the measurement of the construct. The indicator reliability is obtained by the factor loading, which is the correlation coefficient between the indicator and its latent construct. Item loadings of 0.7 are considered acceptable since 50 per cent of the variance of an indicator can be explained by the latent construct (Henseler et al. 2009). The result from the SmartPLS output (see Table 6.3) showed that the majority of the indicators demonstrated acceptable reliability, with loadings above the recommended level of 0.7, although there were some indicators (ESR9, ESR10 of ESS; ESR1, ESR2 of ESR; ESHM7 of ESH and ES_FS of ESF) where the loading fell slightly below 0.7. The item loadings of the variables were further assessed for significance through bootstrapping. All the t-values were greater than the minimum threshold of 1.96 (0.05 significance level) indicating that the correlations between items within the constructs were significant (see Appendix 6.3). In addition, the composite reliability measure (construct reliablity) indicates good internal consistency reliability, with the CR values of all the constructs above the recommended critical value of 0.6. The Cronbach's alphas of the constructs are all greater than 0.7 except ESF, with a value of 0.624. However, since ESF is an exploratory construct the minimum threshold 0.6 can be applied, and thus ESF has acceptable construct reliability. The AVE values of all the constructs were greater than 0.5, confirming convergent validity. The results were all higher than the threshold value, which indicates that there is convergent validity in the first order constructs.

Convergent validity of the second and third order constructs

The tests of validity and reliability for a second and third order factor model follow the same process used to examine the validity of the first order factor (Chin 2010). The latent construct of the lower order latent constructs are considered as the indicators for one level higher order latent construct. For the second order construct, the first order constructs act as their measurement indicators. The path coefficients between the first order constructs and the second order construct are the factor loadings, which can be obtained from the SmartPLS output. The construct reliability and AVE values are measured manually using the following formulae (Wetzels et al. 2009):

Construct reliability = $\frac{(\sum_i \lambda_i)^2}{(\sum_i \lambda_i)^2 + \sum_i var(\varepsilon_i)}$ AVE = $\frac{\sum_i \lambda_i{}^2}{\sum_i \lambda_i{}^2 + \sum_i var(\varepsilon_i)}$ $var(\varepsilon_i) = 1 - \lambda_i{}^2$

Tables 6.4 and 6.5 summarise the results of the convergent validity evaluation on the two second order constructs OA and ESHM and the third order construct ESC.

Table 6.4 T-values of the Path Coefficients of Second Order Factors and Third Order Factors

	Sample Mean	Standard Deviation	Standard Error	T Statistics
ESC→ESF	0.553	0.052	0.052	10.498
ESC→ESHM	0.834	0.038	0.038	22.240
ESC→EST	0.909	0.016	0.016	55.781
ESHM→ESH	0.883	0.025	0.025	35.231
ESHM→ESM	0.797	0.030	0.030	26.641
ESHM→ESV	0.513	0.078	0.078	6.560
OA→OA_C	0.830	0.028	0.028	29.354
OA→OA_O	0.891	0.019	0.019	46.141
OA→OA_P	0.662	0.074	0.074	9.118

The t-values of the path coefficients between the second order constructs OA and ESHM and their first order constructs, and between the third order construct ESC on its respective second order constructs are all greater than the minimum requirement of 1.96 (see Table 6.4), indicating that the measurement model of the second order constructs yields significant path coeffcients.

As can be seen from Table 6.5, constructs OA and ESHM have high construct reliability (greater than 0.7) indicating high internal consistency and the measures all consistently represent the same latent construct (Hair et al. 2010). The constructs OA and ESHM have high AVE values (0.647 and 0.558, respectively) which are greater than the minimum threshold of 0.5. The third order construct ESC has both an AVE value (0.606) and construct reliability (0.816) greater than the required minimum threshold.

Table 6.5 Validity and Reliability Analysis of the Second Order Measurement Model

High Order Construct	Low Order Construct	SFL	AVE	Construct Reliability
OA	OA_C	0.831	0.647	0.844
	OA_O	0.893		
	OA_P	0.673		
ESHM	ESH	0.883	0.558	0.783
	ESM	0.795		
	ESV	0.513		
ESC	ESF	0.547	0.606	0.816
	ESHM	0.833		
	EST	0.909		

In summary, all the dimensions to evaluate the convergent validity are higher than the threshold values, which confirms that there is convergent validity in the second and third order constructs.

6.3.3.2 Discriminant validity

Discriminant validity examines if each measure is strongly related to the construct it attempts to reflect, but at the same time does not have a strong connection with another construct (Hair et al. 2010). Disciminant validity is analysed for the first and second order constructs separately.

For the first order constructs, discriminant validity was tested at both the item and the construct levels. Appendix 6.4 provides the correlations of each indicator to its intended construct (primary loading) and all other constructs (cross-loading). The results show that the item loadings are higher than the cross-loadings, confirming discriminant validity at the item level. At the construct level, discriminant validity indicates that the average variance shared between a construct and its measures should be greater than the variance shared by that construct and any other constructs in the model (Chin 1998; Campbell & Fiske 1959). Therefore, discriminant validity can be tested by comparing if the square roots of AVE exceed the corresponding off-diagonal correlation values in the corresponding rows and columns. The results in Table 6.6 show that the AVE values are greater than their respective squared correlations, which indicates good evidence of discriminant validity.

Table 6.6 First Order Latent Construct Correlation Matrix

	ESF	ESH	ESM	ESR	ESS* ESR	ESS	EST	ESV	OA_C	OA_O	OA_P
ESF	**0.812**	0	0	0		0	0	0	0	0	0
ESH	0.312	**0.762**	0	0		0	0	0	0	0	0
ESM	0.371	0.482	**0.857**	0		0	0	0	0	0	0
ESR	0.408	0.344	0.436	**0.759**		0	0	0	0	0	0
ESS* ESR	0.121	0.124	0.005	-0.064	**0.534**						
ESS	0.486	0.308	0.474	0.661	-0.119	**0.759**	0	0	0	0	0
EST	0.401	0.427	0.466	0.651	-0.138	0.652	**0.775**	0	0	0	0
ESV	0.217	0.289	0.267	0.207	-0.005	0.292	0.357	**0.876**	0	0	0
OA_C	0.401	0.310	0.487	0.426	0.217	0.419	0.351	0.189	**0.850**	0	0
OA_O	0.374	0.407	0.451	0.492	0.235	0.439	0.442	0.177	0.586	**0.782**	0
OA_P	0.255	0.117	0.185	0.237	0.355	0.228	0.190	0.170	0.359	0.480	**0.855**

To test the discriminant validity of the second order constructs, the square root of the AVE values is compared with the correlations among the constructs (see Table 6.7). This was performed for the models including the second order factors and eliminating the first order factors making up the second order construct.

Table 6.7 Second Order Latent Construct Correlation Matrix

	ESF	ESHM	ESR	ESS	EST	OA
ESF	**0.812**	0	0	0	0	0
ESHM	0.401	**0.747**	0	0	0	0
ESR	0.408	0.448	**0.759**	0	0	0
ESS	0.486	0.461	0.661	**0.759**	0	0
EST	0.401	0.545	0.651	0.652	**0.775**	0
OA	0.435	0.493	0.505	0.470	0.432	**0.804**

The discriminant validity test of the third order construct was conducted similarly (Table 6.8). The results in Tables 6.6, 6.7 and 6.8 indicate good discriminant validity for all the constructs.

Table 6.8 Third Order Latent Construct Correlation Matrix

	ESC	ESR	ESS	OA
ESC	**0.778**	0	0	0
ESR	0.654	**0.759**	0	0
ESS	0.670	0.661	**0.759**	0
OA	0.542	0.505	0.470	**0.804**

6.4 ASSESSING THE FINAL RELIABILITY OF THE MEASUREMENT MODEL

The final reliability of the measurement model was tested through construct reliability and calculation of Cronbach's alpha. Tables 6.3 and 6.5 present the results for the reliability analysis of the first order and second order measurement models. Overall, the analysis of validity and reliability of the measurement models confirm the appropriateness of the constructs and their indicators. The next step, analysing the evidence supporting the theoretical model, will be discussed in the next chapter.

6.5 SUMMARY

In this chapter, the measurement model was validated through a rigorous process that consisted of several systematic tests. The internal consistency reliability was initially assessed in Section 6.2, followed by content validity testing in Section 6.3.1 and factorial validity testing by EFA in Section 6.3.2. The result of the EFA suggested that the constructs OA and ESC should be respecified as high order constructs. Validity and reliability were tested for all constructs at lower and higher order levels to ensure their construct validity. The validity dimension was examined using SEM and convergent validity and discriminant validity, and is reported in Section 6.3.3. The reliability dimension was tested in Section 6.4. The measurement model developed shows sufficient rigour and will be used in the next chapter in building a structural model and testing the hypotheses.

As a result of the instrument validation process and the factor structure that emerged for ESC, Hypotheses 5 and 6 have been respecified as follows:

Hypothesis 5a: *Organisations that have developed a high level of EST are more likely to exploit that competence in order to build their ESS capability.*

Hypothesis 5b: *Organisations that have developed a high level of ESH are more likely to exploit that competence in order to build their ESS capability.*

Hypothesis 5c: *Organisations that have developed a high level of ESM are more likely to exploit that competence in order to build their ESS capability.*

Hypothesis 5d: *Organisations that have developed a high level of ESV are more likely to exploit that competence in order to build their ESS capability.*

Hypothesis 5f: *Organisations that have developed a high level of ESF are more likely to exploit that competence in order to build their ESS capability.*

Hypothesis 6a: *Organisations that have developed a high level of EST are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6b: *Organisations that have developed a high level of ESH are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6c: *Organisations that have developed a high level of ESM are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6d: *Organisations that have developed a high level of ESV are more likely to exploit that competence in order to build their ESR capability.*

Hypothesis 6f: *Organisations that have developed a high level of ESF are more likely to exploit that competence in order to build their ESR capability.*

CHAPTER 7: DATA ANALYSIS—STRUCTURAL MODEL VALIDITY

7.1 INTRODUCTION

In the previous chapter, the first phase of the two-step model building approach proposed by SEM and the IS literature (Lewis et al. 2005, Hair et al. 2010), that is, the validation of the measurement model, was presented. Various validity and reliability tests were conducted to ensure the rigour of the measurement model. The current chapter continues with the second phase of the model building through the validation of the structural model. In this study, it is argued that organisations leverage and exploit their unique ESC to enable the processes of organisational sensing and responding to changes from the business environment to build new capabilities that contribute to OA. Results from the data screening in Chapter 6 reveal that the dataset contains a number of abnormally distributed variables. Therefore, this study uses PLS estimation (Wold 1982, 1985, Chin 2000) particularly with SmartPLS (Ringle et al. 2005) to build the structural equation model and test the proposed hypotheses. PLS estimation is distribution-free and does not require variables to be normally distributed (Chin 1998).

The chapter is structured as follows. First, the structural relationships within the developed framework illustrating the hypotheses are tested in Section 7.2. The alternative models that are derived from rival theories are discussed in Section 7.3, and finally, a summary of the chapter is provided in Section 7.4.

7.2 ASSESSING THE VALIDITY OF THE STRUCTURAL MODEL

The validity of the structural model was tested in three steps. First, ESC was modelled as a second order construct, then ESC was modelled based on the five first order constructs, and finally, the moderating impact of ED was tested.

7.2.1 Validating the Structural Model with Enterprise System Competence As a Second Order Construct

A structural model establishes that each linked path between constructs represents a hypothesis to be tested. The major emphasis in analysing the validity of a structural model is on three dimensions: variance explained (R^2), the significance of all path estimates (*β)* and the effect size ($f^{2)}$ (Wetzels et al. 2009).

The R^2 values represent the predictive power or variance that is explained by the model of the endogenous constructs (Hair et al. 2010). It reflects the goodness-of-fit of the regression function with the empirical manifested items from the dataset . R^2 values greater than 0.67, 0.33 and 0.19 are viewed to be substantial, mediocre or weak, respectively (Chin 1998).

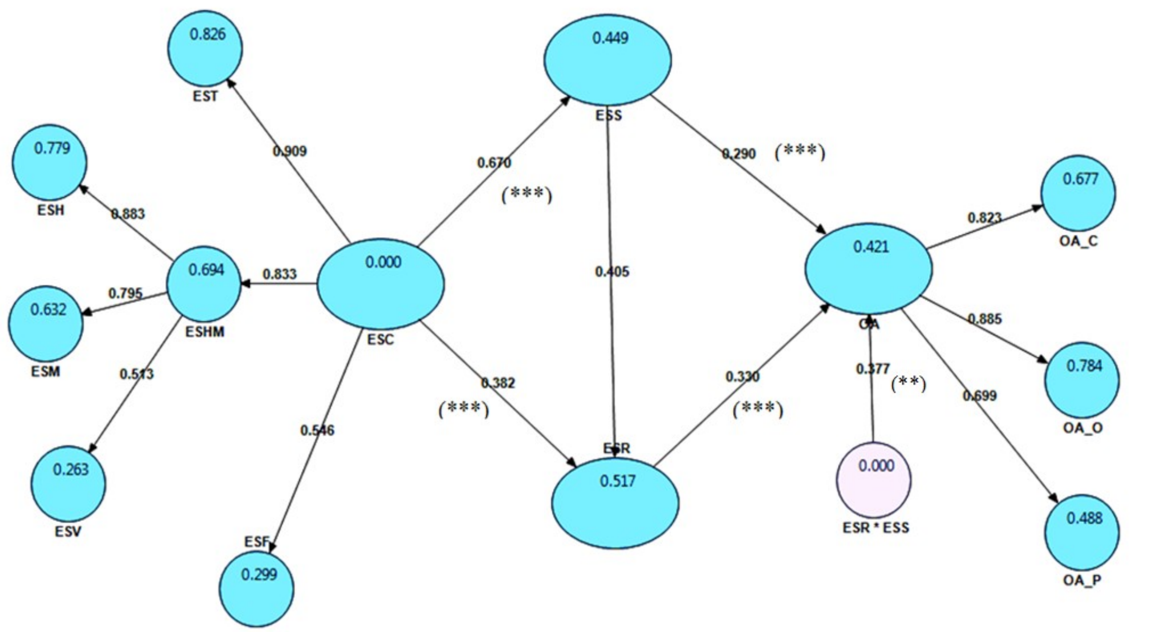
The corresponding standardised path estimates (*β)* represent the strength, direction and significance of the relationship between constructs. *β* is considered to be large, medium and small for values of greater than 0.37, 0.24 and 0.19, respectively (Cohen 1992). The significance of *β* indicates if a relationship exists and in PLS it can be measured through the bootstrapping method. The requirement for *β* to be significant follows the standard suggested by Hair et al. (2010) that the relative t value should be greater than 1.96, which is equivalent to the 95 per cent confidence interval. A positive *β* indicates the direction of the relationship as hypothesised, while a negative *β* indicates the direction of the relationship is opposite that hypothesised.

The effect size, Cohen's f^2, is measured by the change in R^2 when a particular independent latent variable is included or excluded according to the formula:

$$f^2 = \frac{R^2_{(included)} - R^2_{(excluded)}}{1 - R^2_{(included)}}$$ (Cohen 1992, p. 157).

$R^2_{(included)}$ refers to the variance of the dependent variable OA when a given latent variable is included while $R^2_{(excluded)}$ indicates the value when a given latent variable is excluded. f^2 values of 0.02, 0.15 and 0.35 can be interpreted as small, medium and large effects, respectively (Henseler et al. 2009, p. 303).

The estimation of the structural relationships in the model was conducted using a bootstrap routine with 1,000 iterations. This size of the bootstrapping sample relates to significances of $p<0.1$ for $t>1.65$, $p<0.05$ for $t>1.96$ and $p<0.001$ for $t>2.58$ (Hair et al. 2010). The structural model was estimated using smartPLS, and the result is illustrated in Figure 7.1.



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 7.1 Structural Model Testing with Enterprise System Competence as a Second Order Construct (Model A)

The model R^2 explains 42.1 per cent, 44.9 per cent and 51.7 per cent of the variance in OA, ESS and ESR respectively. Chin (1998) classifies R^2 values of greater than 0.67, 0.33 and 0.19 as substantial, mediocre and weak, respectively. These results are above satisfactory, and thus, support the validity as well as utility of the structural model. The R^2 values of ESS and ESR are large (0.449 and 0.517, respectively). The outer weight R^2 values of the constructs ESV (0.263) and ESF (0.299) indicate that only 26.3 per cent and 29.9 per cent of the variance of the two latent constructs can be explained by their indicators respectively. The R^2 values of ESV and ESF are relatively small according to Chin 1998's rule-of-thumb for R^2 classification. Nevertheless, the other psychometric measures of the two constructs in Chapter 6 indicate their validity and reliability.

The structural path coefficient indicates the direction and strength of the relationships between constructs. To test the reliability of the structural model, the t-values that were generated through bootstrapping were assessed. The result of the hypothesis testing summarised in Table 7.1 indicates that all the paths are valid and fit for interpretation and the six main hypotheses were supported. β is considered to be large, medium and small for values of greater than 0.37, 0.24 and 0.1 respectively (Cohen 1992). A standardised path coefficient should be above 0.20 to be considered meaningful (Meehle 1990). The results of the standardised path coefficients shows that except for H1 (β=0.29) and H2 (β=0.33) which indicate medium positive relationships, the other relationships (H3, H4, H5, and H6) are large. The impact of the alignment of ESS and ESR on OA is positively large and significant at the 0.05 level (β=0.377, t=2.061), indicating that hypothesis H4 is supported.

Table 7.1 Hypotheses Testing Results for the Original Model

Hypothesis	Relationship	β-value	Standard Error	T-value	P-value	Remark
H1	ESS→OA	0.291	0.091	3.209	<0.01	Supported
H2	ESR→OA	0.330	0.084	3.913	<0.01	Supported
H3	ESS→ESR	0.405	0.078	5.214	<0.01	Supported
H4	ESR*ESS→OA	0.377	0.183	2.061	<0.05	Supported
H5	ESC→ESS	0.670	0.045	14.838	<0.01	Supported
H6	ESC→ESR	0.382	0.064	5.946	<0.01	Supported

The effect size f^2 values shown in Table 7.2 indicate a medium effect size for the constructs ESS (f^2=0.29) and ESS*ESR (f^2=0.23) and a high effect size for the construct ESR (f^2=0.35) on the overall model explanation power, indicating the utility of ESS and ESR to the model. In addition, the inclusion of the interaction term (ESS*ESR) also contributes to the overall R^2 value. This result confirms the importance of ES sensing and responding alignment and indicates further support for hypothesis H4.

Table 7.2 Effect Size f^2 of Latent Variables

Latent Variable	R^2 Included	R^2 Excluded	f^2	Result
ESS	0.421	0.251	0.29	Medium
ESR	0.421	0.219	0.35	Medium
ESS*ESR	0.421	0.288	0.23	Medium

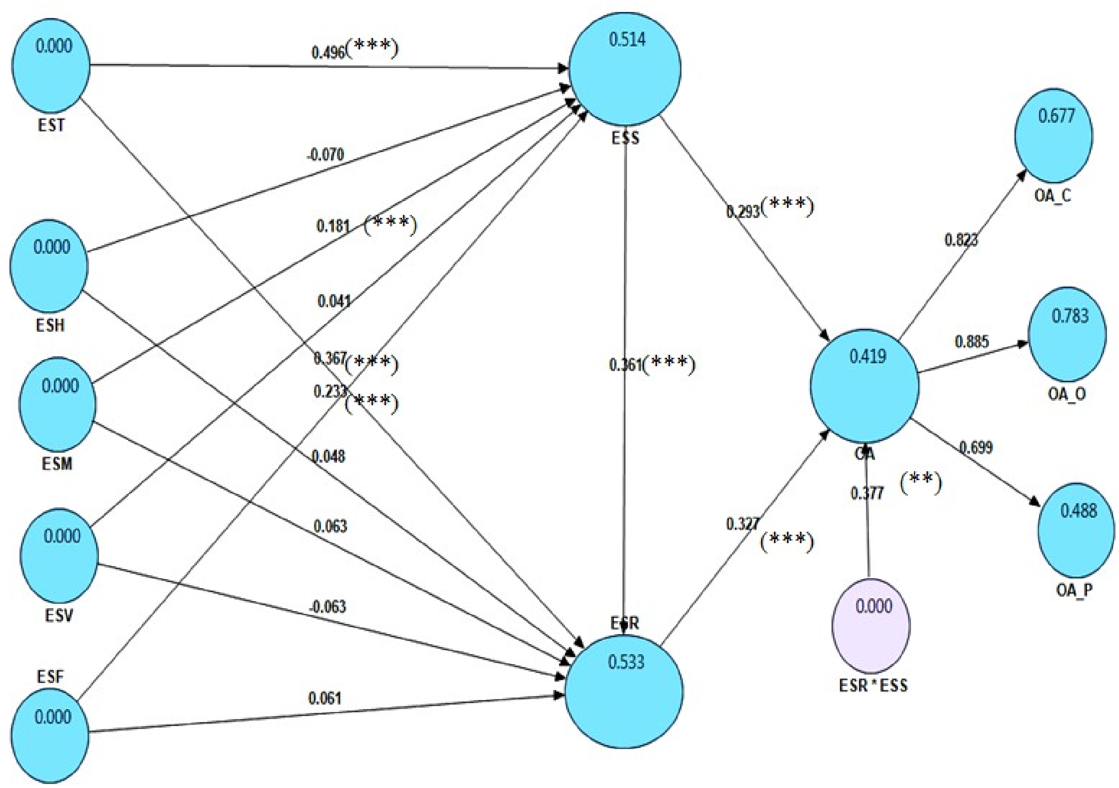
Table 7.3 reports the effect sizes between constructs. Except for the moderating effect of the ES sensing and responding alignment on OA which was significant at the 0.05 level, all other relationships were significant at the 99 per cent confidence interval. ESR has larger direct effect on OA (β=0.330) compared to ESS (0.290). The variance in ESC better predicts the variance in ESS (β=0.670) than in ESR (β=0.405). However, when calculating the total effects, composed of both direct and indirect effects, the total effect of ESC→ESR (β=0.653) is similar to the total effect of ESC→ESS (β=0.670). The total effect also shows a large and positive relationship (Table 7.3).

Table 7.3 Total Effect Sizes

Relationship	Direct Effects	Indirect Effects	Total Effects
ESC→ESS	0.670		0.670
ESS→ESR	0.405		0.405
ESR*ESS→OA	0.377		0.377
ESR→OA	0.330		0.330
ESC→ESR	0.382	0.271	0.653
ESS→OA	0.290	0.134	0.424
ESC→OA		0.410	0.410

7.2.2 Validating the Structural Model With Enterprise System Competence As a First Order Latent Variable

Since the second subresearch question asks about the ESC contribution to the development of ESS and ESR capabilities, the five competences of ESC identified after initial validation were tested. The five constructs suborder constructs are EST, ESH, ESM, ESV and ESF. They are hypothesised to directly impact on ESS as H5a, H5b, H5c, H5d and H5e. Respectively, the hypotheses that represent the impact of EST, ESH, ESM, ESV and ESF on ESR are named as H6a, H6b, H6c, H6d and H6e (See Section 6.5, Chapter 6). The figure 7.2 below illustrates the structural model with ES competence as first order latent variable (Model B).



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 7.2 Structural Model Testing with Enterprise System Competence as a First Order Latent Variable (Model B)

Figure 7.2 shows the testing and results of the structural model with ESC as first order latent variable. The model R^2 explains 41.9 per cent, 51.4 per cent and 53.3 per cent of the variance in OA, ESS and ESR respectively. According to Chin's (1998) classification of R^2 values, all the R^2 values of these three constructs present moderate to substantial effects, and hence support the validity and utility of the structural model. These values are not greatly different from the values reported in Section 7.2.1.

Table 7.4 Hypotheses Testing of the Model (Enterprise System Competence as a First Order Construct)

Hypothesis	Relationship	Beta-value	Standard Error	T-value	P-value	Remark
H1	ESS→OA	0.293	0.091	3.234	<0.01	**Accepted**
H2	ESR→OA	0.327	0.084	3.895	<0.01	**Accepted**
H3	ESS→ESR	0.361	0.076	4.719	<0.01	**Accepted**
H4	ESR*ESS→OA	0.377	0.188	2.012	<0.05	**Accepted**
H5a	EST→ESS	0.496	0.063	7.933	<0.01	**Accepted**
H5b	ESH→ESS	-0.070	0.071	0.985	>0.1	Rejected
H5c	ESM→ESS	0.181	0.073	2.468	<0.05	**Accepted**
H5d	ESV→ESS	0.041	0.063	0.651	>0.1	Rejected
H5e	ESF→ESS	0.233	0.054	4.299	<0.01	**Accepted**
H6a	EST→ESR	0.367	0.070	5.247	<0.01	**Accepted**
H6b	ESH→ESR	0.048	0.070	0.676	>0.1	Rejected
H6c	ESM→ESR	0.063	0.073	0.867	>0.1	Rejected
H6d	ESV→ESR	-0.063	0.055	1.147	>0.1	Rejected
H6e	ESF→ESR	0.062	0.064	0.966	>0.1	Rejected

Table 7.4 summarises the hypothesis testing of the model with ESC structured as a first order construct. Similar to the structural validation of the model constructing ESC as the second order in presented in Section 7.2.1, the results indicate that hypotheses H1, H2, H3 and H4 are supported. All the standardised path coefficients representing these relationships are above 0.20, which fulfils the requirement for the relationship they represent to be meaningful (Meehe 1990). In detail, hypothesis H1 (β=0.293, t=3.234), H2 (β=0.327, t=3.895), H3 (β=0.361, t=4.719), H4 (β 0.377, t=2.012) indicate significantly positive influence of ESS on OA, ESR on OA, ESS on ESR, and ESS*ESR on OA. According to

the classification of standardised path coefficients by Cohen (1992), H1, H2, H3, and H4 have standardised path coefficients from medium to large.

For the hypotheses that demonstrate the propositions on the impact of ESC on ESS and ESR, only H5a, H5c, H5e, and H6a are supported. Specifically, EST shows a significantly positive impact on both ESS (H5a: β=0.496, t=7.933) and ESR (H6a: β=0.367, t=5.247). Both of these influences are greater than 0.37 and are classified as large. The impact of ESM on ESS (β=0.181, t=2.468) indicates a significant and positive relationship. Hence, hypothesis H5c is supported, although its impact is small (Cohen 1992). The influence of ESF on ESS (β=0.233, t=4.299) is statistically significant at the 99 per cent significance level, suggesting that hypothesis H5e is accepted. The structural model testing result also indicate that except for EST which has a direct impact on ESR (H6a), the impact of all the other ESC constructs (ESH, ESM, ESV, and ESF) on ESR is not significant (the p-values of H6b, H6c, H6d, H6e are all larger than 0.05). Likewise, the impact of ESH on ESS (β=-0.070, t=0.985) and ESV on ESS (β=0.041, t=0.651) are not significant due to their t-values being less than 1.96 for the 95 per cent significance level. Hence, hypotheses H5b and H5d are not supported.

In summary, the structural model validation, which is built on the assumption of ESC as a first order construct and consists of five constructs: EST, ESH, ESM, ESV and ESF, suggests that only EST has a statistically significant influence on both ESS and ESR. Both ESM and ESF have a significant impact on ESS but their relationships with ESR are not statistically significant. Surprisingly, both ESH and ESV show no significant impact on either ESS or ESR.

7.2.3 The Moderating Effect of Environmental Dynamism

For the sake of parsimony, the model to be used for testing the moderating effect of ED will be the original model, which uses ESC as a second order construct.

Hypothesis 7 postulates that ED acts as a control variable that impacts on the relationships stated in the structural model. Organisations that operate in dynamic business environments are more likely to develop high ESC and high ES-enabled sensing and responding capability than those that operate in a relatively stable environment. There are three approaches to assess moderating effects in PLS path model validation: the product indicator approach, group comparison and the two stage approach (Henseler & Fassott 2010).

The product indicator approach introduces and evaluates the moderating variable interaction term into the structural model. The endogenous variable comprises not only the main effect under consideration from the independent and moderator variables but also from an interaction variable created as a product of the two (Eberl 2010). Product indicators of a latent interaction variable can be constructed from independent and moderator variables. If an independent variable has m items and a moderator variable has n items, the latent interaction variable would have m x n items. In detail, each item of the latent interaction variable is the product of each item of the independent variable with each item of the moderator variable (Chin et al. 2003).

The group comparisons approach typically splits the sample into groups. Subgroups can be formed based on the distinct differences in the level of the moderator variable (Eberl 2009). The median sample splits by a criterion variable is commonly used (Henseler & Fassott 2009; Keil et al. 2000). A sample whose ED score is below the median is classified under the low-ED group, samples whose ED score are above the medium are in the high-ED group. The same PLS path model can be estimated in each of the distinct subsamples.

The two stage approach is a default approach for formative measurement constructs rather than reflective measurement constructs (Henseler & Fassott 2010). Since all the constructs in the current study are reflective constructs, the third approach is not relevant here.

While the product indicator approach works best for continuous moderator variables, the group comparison approach works best for categorical moderator variables or otherwise non-continuous and discrete variables (Henseler & Fassott 2009). Henseler and Fassott (2009) comment that the group comparison technique is suboptimal for continuous moderating variables. First, the dichotomisation (e.g., splitting into two groups: high and low) causes part of the moderator variable's variance to be lost to analysis. Second, the assignment of observations into groups is arbitrary. Likewise, the product indicator approach is not free from bias. A drawback of this method is that it is not possible to interpret the moderator variable's impact on predictor variable's weights or loading (Eberl 2009).

Since ED is a latent variable that was measured by continuous-assumed indicators, either the product indicator or multi-group analysis can be used to test for moderation. Furthermore, the multi-group method compares path coefficients between two groups to identify differences between them. Hence, it helps to identify the impact of a moderating construct on the relationship between two other constructs in the model. However, this method does not provide conclusions on how a moderating construct itself impacts on each of the constructs and their relationships. For example, the ED construct is hypothesised to moderate the relationship between ESS and OA (H7a). Therefore, both approaches were used and compared to help achieve a better result. Hence, testing the moderating effect of ED on the structural model was accomplished by following both the multi-group and product indicator approach (Tallon 2008, Chin et al. 2003).

7.2.3.1 Assessment using multi-group analysis

The purpose of this analysis was to compare the differences in impact between organisations that operate in more dynamic business environments with those that operate in more stable business environments. Therefore, the data file was split into two groups: the first consisting of cases with values of ED above the median of the scale, and the second group consisting of cases with values of ED below the median (Tallon 2008). The low-ED group comprised 77 cases while the high-ED group contained 102 cases.

The goal of the multi-group analysis was to assess whether the path coefficients differed significantly across the groups. Although several approaches to multi-group analysis have been introduced in PLS research (Henseler et al. 2009; Sarstedt et al. 2011), this study adopted the approach developed by Keil et al. (2000) and Chin (2000), which has been widely used in literature, proving its rigour and effectiveness (Eberl 2009). The approach involves estimating model parameters for each group separately and using standard errors obtained from bootstrapping as the input for a parametric test (Keil et al. 2000). Hence, differences between the path estimators are tested for significance with a t-test (Eberl 2009).

The structural path model was run separately for each group using SmartPLS. The bootstrapping sample size was set to 1,000 in accordance with the commonly suggested rule of thumb. Each pair of the path coefficients of the two models was compared. The t-values for multi-group difference effects were measured according to the formula proposed by Chin et al. (2003) given below. The result of this analysis is summarised in Table 7.5, which displays the complete list of all the endogenous constructs and their R^2 for the model tested with two subgroups (i.e., the high ED group and low ED group), and Table 7.6 which demonstrates the impact of ED on the paths of the structural model using multi-group analysis.

$$t = \frac{Path_{sample\_1} - Path_{sample\_2}}{\left[\sqrt{\frac{(m-1)^2}{(m+n-2)} * S.E.^2_{sample1} + \frac{(n-1)^2}{(m+n-2)} * S.E.^2_{sample2}}\right] * \left[\sqrt{\frac{1}{m} + \frac{1}{n}}\right]}$$

Table 7.5 Impact of Environmental Dynamism on the Endogenous Variables in the Structural Model

Endogenous Constructs	R^2				T-value	P-value
	Full Sample (n=179)	High ED-group (n=102)	Low ED-group (n=77)	Different		
OA	0.421	0.390	0.348	0.042	0.561	0.57552
ESS	0.449	0.467	0.430	0.037	0.494	0.62185
ESR	0.517	0.468	0.588	-0.12	-1.613	0.10850

The results shown in Table 7.5 demonstrate that the R^2 values of the endogenous reflective constructs of each subsample are acceptable and sufficiently high. They are within the range from moderate to large according to the rules of thumb for R^2 (Chin 1998). The results also show that differences in the variance explanation of the model (R^2) between the two subsamples categorised by high and low ED was not statistically significant ($p>0.05$). Hence, the multi-group analysis shows that ED does not moderate the relationship between the constructs of the model.

7.2.3.2 Assessment using product indicator analysis

Here, ED is hypothesised as a control variable that moderates all relationships in the model. Hypothesis H7 is thus restructured into eight subhypotheses, from H7a to H7i, as presented in Table 7.6 below. The product indicator approach is not able to estimate the impact of ES on all of the relationships of the model at the same time. Therefore, the model is re-estimated each time the moderating effect of ED is examined on a particular relationship. The results of these tests are presented in Table 7.6.

The moderating effects of ED on the relationships between the two constructs which are indicated as the paths in the structural model (H7a, H7b, H7c, H7d, H7e) were rejected (p-values >0.1). Therefore, ED does not impact on the relationship between the constructs of the model.

Table 7.6 Impact of Environmental Dynamism on the Paths of the Structural Model Using Product Indicator Analysis

Hypothesis	Relationship	β-value	Standard Error	T-value	P-value	Remark
H7a	ED*ESS→OA	0.18	0.13	1.45	0.15	Rejected
H7b	ESR*ED→OA	0.12	0.12	0.96	0.34	Rejected
H7c	ESS*ED→ESR	-0.02	0.14	0.11	0.91	Rejected
H7d	ESC*ED→ESS	-0.25	0.30	0.84	0.20	Rejected
H7e	ESC*ED→ESR	0.25	0.21	1.19	0.12	Rejected
H7f	ED→OA	0.28	0.07	4.25	0.00	**Accepted**
H7g	ED→ESS	-0.05	0.06	0.85	0.40	Rejected
H7h	ED→ESR	0.13	0.06	2.15	0.03	**Accepted**
H7i	ED→ESC	0.38	0.07	5.58	0.00	**Accepted**

However, ED positively correlated with OA (H7f: β=0.281, p<0.001) and ESR (H7h: β=0.125, p<0.05) and ESC (H7i: β=0.380, p<0.001). These relationships are significant. The impact of ED on the framework is measured through its effect size. The effect size f^2 values shown in Table 7.7 indicate a medium effect of ED (f^2=0.152) on the overall model's explanatory power. Conversely, ED may be negatively correlated with ESS (β=-0.053), however, the results obtained from the bootstrap methodology showed that this relationship is not significant.

Table 7.7 Effect Size of Environmental Dynamism

Latent Variable	R^2 Included	R^2 Excluded	f^2	Result
ED	0.498	0.421	0.152	Medium
ED (on ESS)	0.529	0.421	0.230	Medium
ED (on ESR)	0.510	0.421	0.181	Medium

The two methods to measure the moderating effect of ED led to the same conclusion: that variation in the extent of ED does not change the impact of ESC on ESS and ESR or the impact of ESS and ESR on OA. The product indicator method provided additional information in regard to the impact of ED on each particular endogenous variable of the structural model. ED has positive and significant direct influence on OA and ESR, but no effect on ESS.

7.2.4 Predictive Validity of the Model

Since the PLS path modelling does not provide goodness-of-fit measures (Henseler et al. 2009), the evaluation of the model's predictive validity was used to assess the model relevance. Predictive relevance can be examined using the Stone-Geisser's Q^2 measure (Stone 1974; Geisser 1975) using blindfolding procedures (Tenenhaus et al. 2005). This technique represents a synthesis of cross-validation and function fitting R^2 between the measurement variables of an endogenous latent variable and all the measurement variables associated with the latent variables explaining the endogenous latent variable, using the estimated structural model (Tenenhous et al. 2005). A Q^2 value greater than 0 implies the model has predictive relevance whereas a Q^2 value smaller than 0 represents a lack of predictive relevance. The Q^2 values of all latent variables were greater than 0, indicating that the model has predictive relevance (Table 7.8).

Table 7.8 Predictive Validity of the Model

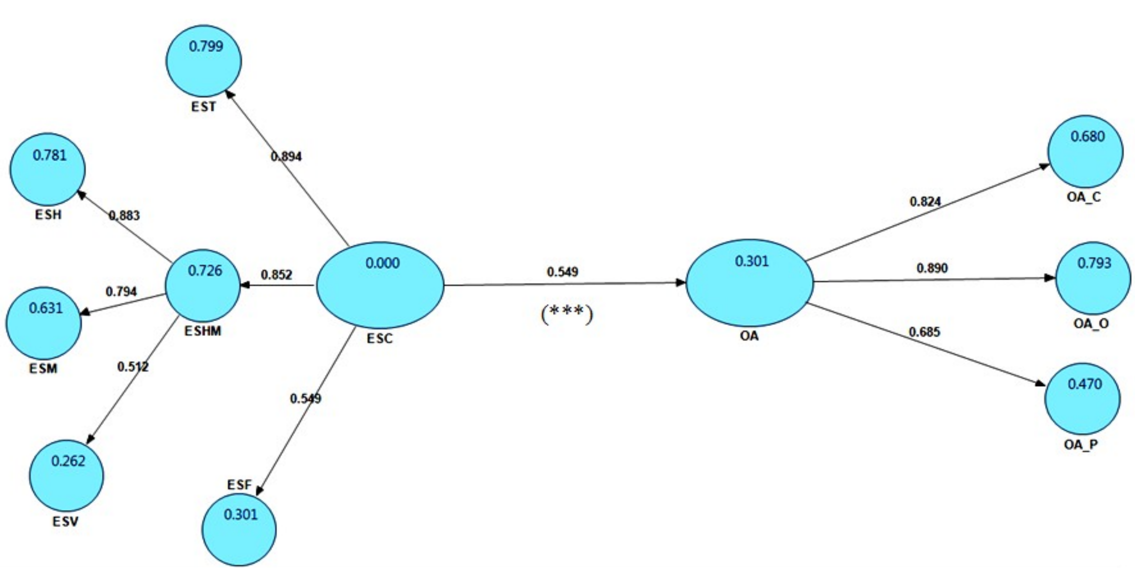
Total	SSO	SSE	1-SSE/SSO
ESF	358	302.891	**0.154**
ESH	895	492.379	**0.450**
ESHM	1790	1291.794	**0.278**
ESM	537	292.340	**0.456**

ESR	1074	761.770	**0.291**
ESS	1790	1334.569	**0.254**
EST	1432	727.327	**0.492**
ESV	358	286.678	**0.199**
OA	1969	1606.814	**0.184**
OA_C	537	278.770	**0.481**
OA_O	895	456.136	**0.490**
OA_P	537	343.779	**0.360**

Overall, given that six out of seven estimates were consistent with the hypotheses; this result supports the theoretical model with the caveat that Hypothesis 7 is not supported.

7.3 RULING OUT RIVAL THEORIES

The current model tests the indirect relationship between ES and OA: ESC is leveraged to generate ESS capability and ESR capability which in turn enables OA. However, the ES and IS literature suggest that ES provides capabilities that directly enable the ability of organisations to capture and respond to change. The direct relationship of ES and OA was tested as an alternative model, entitled Model C, with ESC as a second order construct (Figure 7.3).

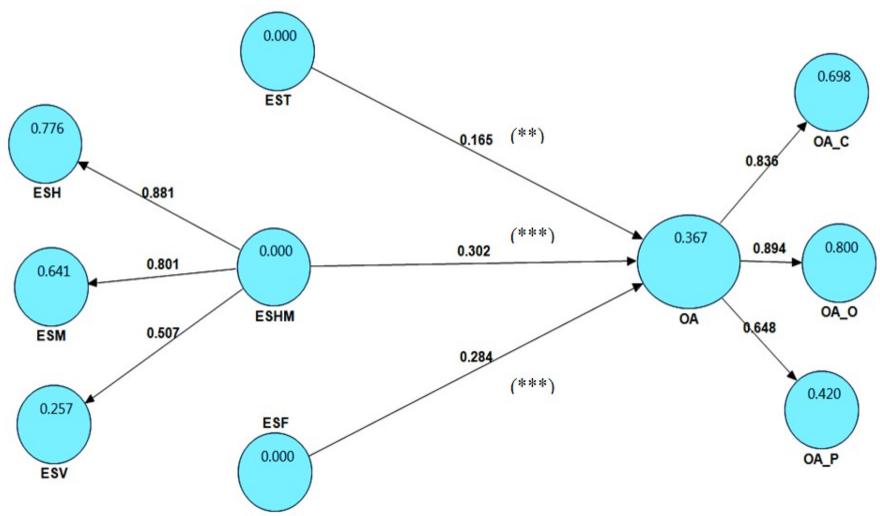


***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 7.3 Structural Model Testing the Direct Relationship of Enterprise System Competence and Organisational Agility with Enterprise System Competence as a Second Order Latent Variable (Model C)

The explanatory power of the variance of OA by the model theorising a direct impact of ESC on OA is R^2=0.301, which is considered as medium. The result shows a significant direct relationship between ESC and OA (β=0.549, p<0.001).

Throughout the assessment, ESC was viewed as a high order construct and the impact of each individual ES subcompetence was excluded from the testing. Model C revealed a significant relationship. Since ESC consists of three subcompetences, EST, ESHM and ESF, the hypotheses on the impact of each individual ES subcompetence will provide further understanding of their roles on the overall level of OA. The alternative model D shown in Figure 7.4 tests the direct relationship of each individual ESC on OA.



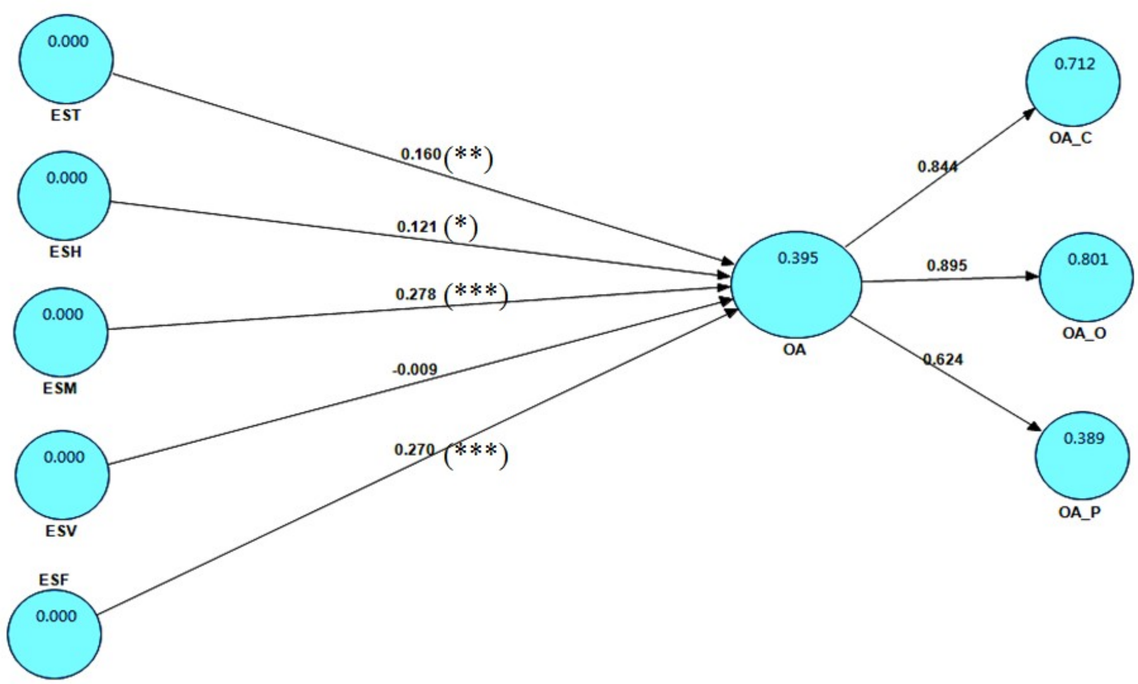
***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 7.4 Structural Model Testing Direct Relationships Between Enterprise System Subcompetences and Organisational Agility (Model D)

The result shows a weak but significant direct relationship between EST and OA (β=0.165, p<0.05), moderate and significant relationships between ESHM and OA (β=0.302, p<0.01), and ESF and OA (β=0.284, p<0.01). This outcome suggests that ESHM and ESF have a greater effect on OA than EST.

In comparison with the alternative model C (Figure 7.3), the framework proposed in alternative model D (Figure 7.4) provides a better explanation of the variance of OA [R^2 (model 2)=0.367>R^2(model 1)=0.301]. Model D explains 36.7 per cent of the variance of OA which is considered large, though still less than the explanatory power of the framework theorising an indirect impact of ESC on OA (Figure 7.1, R^2=0.421). In sum, the framework hypothesising an indirect relationship between ESC and OA shows a better explanatory power of the variance of OA than the framework that theorises a direct relationship.

Model C and Model D test the structural model with ESC is specified as a high-order construct. To further investigate the direct impact of the five sub-order constructs EST, ESH, ESM, ESV and ESF on OA, the model E bellow is structured.



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

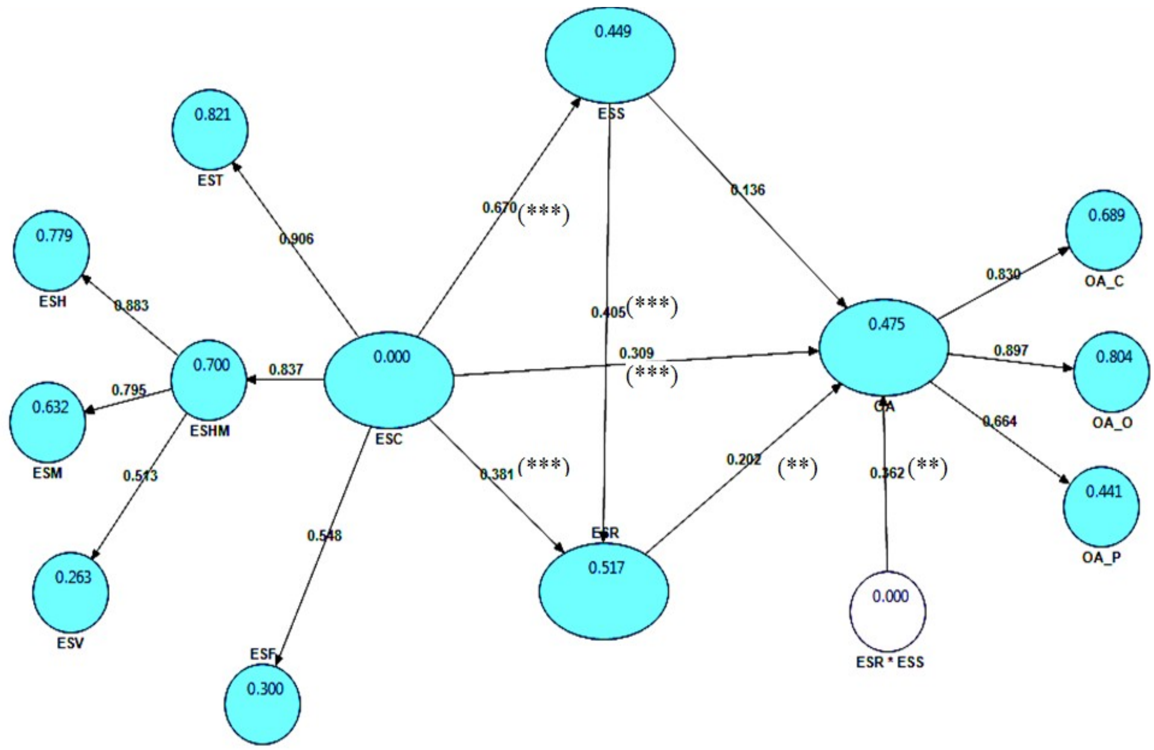
Figure 7.5 Structural Model Testing Direct Relationships Between Enterprise System Competence and Organisational Agility with Enterprise System Competence as a First Order Latent Variable (Model E)

The model E explains 39.5 per cent of the variance in OA. This indicates a moderate effect according to Chin's (1998) classification of R^2 value. Table 7.9 below outlines the results of the direct relationship testing between EST, ESH, ESM, ESV, and ESF and OA. The results indicate that excluding the ESV, the other four sub order construct of ESC have a significant and direct relationship with OA.

Table 7.9 Result of the Model with Direct Relationships between Enterprise System Competence and Organisational Agility and Enterprise System Competence as a First Order Latent Variable

Relationship	Beta-value	Standard Error	T-value	P-value	Remark
ESF -> OA	0.270	0.060	4.475	<0.01	**Supported**
ESH -> OA	0.121	0.063	1.916	<0.1	**Supported**
ESM -> OA	0.278	0.070	3.977	<0.01	**Supported**
EST -> OA	0.160	0.076	2.114	<0.05	**Supported**
ESV -> OA	-0.009	0.059	0.158	>0.1	Rejected

From the model A and model C, the explanatory power of the variance of OA by an indirect impact of ESC on OA is relatively large (R^2=0.421). However, the explanatory power of the variance of OA by a direct impact of ESC on OA (R^2=0.301) is mediocre. This result suggests that ESR and ESS partially mediate the impact of ESC on OA. Therefore, it is necessary to test the model hypothesising both direct and indirect relationships between ESC and OA. An alternative model 2 including both direct and indirect relationships between ESC and OA was tested. The result is illustrated in Figure 7.6 and Table 7.10.



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 7.6 Alternative Model with and Indirect Relationships between Enterprise System Competence and Organisational Agility (Model F)

Table 7.10 Result of the Model with Direct and Indirect Relationships between Enterprise System Competence and Organisational Agility

Relationship	β	Standard Error	T-value	P-value	Remark
ESC→ESR	0.3812	0.0641	5.9479	0.0000	Accepted
ESC→ESS	0.6699	0.045	14.8809	0.0000	Accepted
ESC→OA	0.3089	0.0901	3.4281	0.0006	Accepted
ESR→OA	0.2024	0.0853	2.3725	**0.0179**	Accepted
ESR*ESS→OA	0.3617	0.1699	2.1295	**0.0335**	Accepted
ESS→ESR	0.4055	0.0798	5.0805	0.0000	Accepted
ESS→OA	**0.1357**	**0.1006**	**1.3488**	**0.1777**	**Rejected**

The model explains 47.5 per cent of the variance of OA (R^2=0.475). It indicates a substantial total of the explanatory power of the model. Furthermore, the explanatory power of this integrated model (R^2=0.475) is higher than that of each model that solely tests the indirect relationship between ESC and OA (R^2=0.421) or the direct relationship between ESC and OA (R^2=0.301).

Moreover, with the inclusion of a direct relationship between ESC and OA into the model, the relationship ESS→OA becomes insignificant (β=0.1357, p=0.1777). This suggests that ESS fully mediates the relationship between ESC and OA.

Conversely, the relationship between ESR and OA (β=0.2024, $p<0.05$) and the relationship between ESR and ESS alignment on OA (β=0.3617, $p<0.05$) remain supported and significant at the 95 per cent significance level. The rest of the relationships are supported at the 99 per cent significance level. Furthermore, the direct relationship of ESC and OA remains significant, although the path coefficient is reduced (from β=0.549 as shown in Figure 7.3, to β=0.309 as shown in Figure 7.6). Therefore, ESR partially mediates the relationship between ESC and OA.

The results indicate that ESC can both directly and indirectly impact OA. ES provide capabilities that directly improve the agility level of an organisation. This direct relationship is logical. For example, the interaction centre of CRM allows customers to mutually interact with the organisation through various channels such as telephone, internet access, and e-mail. The customer data captured from the interaction centre are immediately recorded in the CRM which enables customer's requests to be immediately analysed and responded to through CRM analysis. Changes in customer preference can be immediately responded to through the CRM system.

The indirect impact of ESC on OA is through the use of information in responding to changes in the business environment. ESS capability does not directly influence OA, but it does have an indirect influence through the mediation of ESR capability, although the interaction between ESS and ESR enables OA.

Comparison of the three models A, C and F suggested a potential rectification of the model. The model was re-estimated with the inclusion of a direct relationship between ESC and OA and resulted in a better fit. The standardised path coefficient was 0.309 with a t-value of 3.428 ($p<0.001$). In addition, the overall explanation of variance in the dependent variable OA was 0.475, which is higher than both the R^2 results of OA measured by other models (direct and indirect relationships between ESC and OA). Several of the path estimates from the original model were changed slightly, as would be expected. Most notably, the ESS→OA relationship (β=0.135, t=1.349, p=0.178) is no longer significant. The relationship ESR→OA remains significant but is substantially smaller than before (from 0.330 to 0.202). A breakdown of the direct and indirect relationship between ESC and OA shows that the direct relationship ESC→OA has a strength of β=0.309 while the indirect relationship ESC→OA has a path coefficient of β=0.223, which is substantial relative to the strength of the direct relationship. Therefore, ESC impacts on OA through both direct and indirect relationships.

The summary of the 6 models introduced in this structural analysis chapter is presented in table 7.11 below.

Table 7.11 Comparison of structural models

Variable/Path	Model A		Model B		Model C		Model D		Model E		Model F	
	Beta	R2	Beta	R2	Beta	R2	Beta	R2	Beta	R2	Beta	R2
OA		0.421		0.419		0.301		0.367		0.395		0.475
ESS		0.449		0.514								0.449
ESR		0.517		0.533								0.517
ESS-->OA	0.290		0.293								0.136	
ESR-->OA	0.330		0.327								0.202	
ESS-->ESR	0.405		0.361								0.405	
ESS*ESR--> OA	0.377		0.377								0.362	
ESC-->OA					0.549						0.309	
ESC-->ESS	0.670										0.67	
ESC-->ESR	0.382										0.381	
EST-->ESS			0.496									
EST-->ESR			0.367									
ESH-->ESS			-0.070									
ESH-->ESR			0.048									
ESM-->ESS			0.181									
ESM-->ESR			0.063									
ESV-->ESS			0.041									
ESV-->ESR			-0.063									

ESF-->ESS			0.233									
ESF-->ESR			0.061									

In summary, the current study proposes a model (Model A) that hypothesises an indirect relationship between ESC and OA. This model shows a better explanatory power compared to the alternative model demonstrating a direct relationship between the two constructs ESC and OA (i.e. model C, model D and model E). Model A also shows slightly better explanation power in comparison with model B which specify ESC as a first order latent variable. The analysis of different alternative models suggests both direct and indirect relationships between ESC and OA (Figure 7.6). The mediation of ESS and ESR capability by the impact of ESC on OA as theorised in the initial framework has been validated. However, with the existence of a direct relationship between ESC and OA, the analysis shows that there is no direct impact of ESS on OA (Figure 7.6). Instead, ESR acts as the mediator in the relationship between ESS and OA. To further understanding on the impact of the sub-order ESC, the model B will be analysed. Table 7.12 summarises the results of the hypothesis testing.

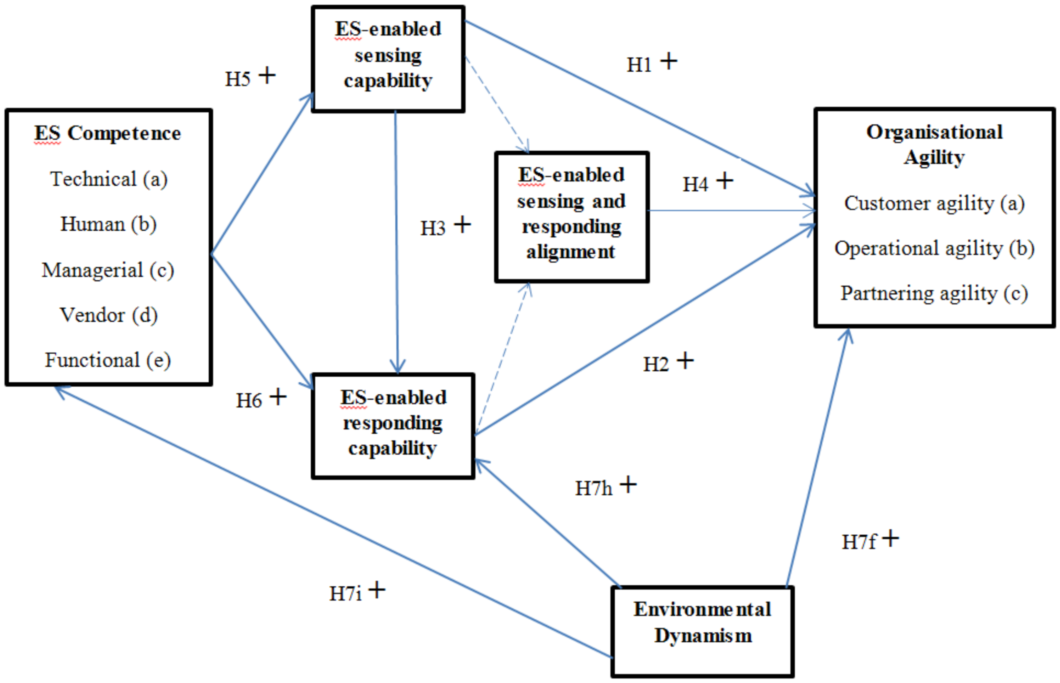
Table 7.12 Hypothesis Testing Result

Hypothesis	β-value	P-value	Supported
H1: ESS capability is positively related to OA	0.291	<0.010	**Yes**
H2: ESR capability is positively related to OA	0.330	<0.010	**Yes**
H3: ESS capability is positively related to ESR capability	0.405	<0.010	**Yes**
H4: Alignment of ESS capability and ESR capability is positively related to OA	0.377	<0.010	**Yes**
H5: ESC is positively related to ESS capability	0.670	<0.010	**Yes**
H6: ESC is positively related to ESR capability	0.382	<0.010	**Yes**
H7a: ED positively moderates the relationship between ESS capability and OA	0.184	0.148	No
H7b: ED positively moderates the relationship between ESR capability and OA	0.116	0.339	No
H7c: ED positively moderates ESS capability support for ESR capability	-0.016	0.909	No
H7d: ED positively moderates ESC support for ESS capability	-0.249	0.200	No
H7e: ED positively moderates ESC support for ESR capability	0.252	0.117	No
H7f: ED positively moderates the level of OA	0.281	<0.010	**Yes**
H7g: ED positively moderates ESS capability	-0.053	0.395	No
H7h: ED positively moderates ESR capability	0.125	<0.050	**Yes**
H7i: ED positively moderates ESC	0.380	<0.010	**Yes**

Six out of seven hypotheses (H1–H6) are significant at the 95 per cent confidence interval. A higher degree of ESC will lead to a higher degree of ESS capability (H5) and ESR capability (H6), which in turn leads to a higher degree of OA (H1, H2, respectively). A higher degree of ESS capability will result in a higher degree of ESR capability (H3). Furthermore, ED positively impacts on the degree of ESC, ESR capability and OA (H7i, H7h and H7f, respectively) but not on ESS capability (H7g). In contrast, ED does not moderate the impact of ESC on ESS (H7d), and ESR capability (H7e) as well as the impact of ESS capability and ESR capability on OA (H7a and H7b, respectively). ED also does not moderate the impact of ESS capability on ESR capability (H7c).

7.4. SUMMARY

In this chapter the hypotheses developed in Chapter 4 were tested through the validation of the full structural model using PLS estimation. While the initial theorised model focuses only on the indirect relationship between ESC and OA through the mediation of ESS and ESR, the result of alternative model testing suggested both a direct and an indirect impact of ESC on OA. Overall, six out of seven estimates were consistent with the hypotheses, except H7, which was partially accepted. Hypothesis 7 suggests that ED acts as a control variable that positively impacts all the constructs and moderates all the relationships proposed in the model. However, only H7f, H7h and H7i are supported. Hypothesis 7f proposes that ES positively impacts OA: higher levels of ES will result in higher levels of OA. Hypothesis 7h proposes that higher levels of ES will lead to higher levels of ESC, and finally Hypothesis 7i assumes that higher levels of ES will produce higher levels of ESC. In summary, these results support the theoretical model, with the caveat that Hypothesis 7 is not supported. Figure 7.7 below summarizes the hypothesis testing:



Note: the (+) sign indicates the hypothesis is supported and the relationship is significantly positive

Figure 7.7 Summary of the structural model validation

CHAPTER 8: DISCUSSION OF THE RESEARCH FINDINGS

8.1 INTRODUCTION

In the previous chapter the validation of the structural model was presented. The results support six of the seven main hypotheses, and also partially support H7, which indicates the moderating effect of ED on the relationships specified in the models. Further, the results provided support for a number of subhypotheses related to ESC and the moderating effect of ED. In this chapter, the hypotheses will be discussed to (a) establish their statistical significance; (b) compare them with the previous literature; (c) interpret the findings; and (d) to identify the practical implications.

The chapter is structured as follows:

- A discussion of the descriptive findings on the diffusion of the ES, OA, ES-enabled sensing and responding capabilities and ESC of the surveyed organisations (Section 8.2).
- An overview of the relationship between ES and OA (Section 8.3).
- The generation of ES-enabled sensing and responding capabilities and their relationship with OA (Section 8.4).
- The components of ESC (Section 8.5).
- The impact of ED on OA (Section 8.6).
- Summary (Section 8.7).

8.2 DESCRIPTIVE FINDINGS

After the data cleaning process, 179 organisations were retained as the final sample. Among them, 153 were large organisations and 26 were medium sized. In addition, the revenue data also indicated that the majority of companies implementing ES had annual revenues of more than AUD 100 million, indicating that they were large organisation with significant financial capabilities. The respondents came from all industries. The largest group was from the manufacturing sector, accounting for 25.1 per cent, followed by service industries (17.3 per cent). Further details on the sample have been provided in the following sections.

8.2.1 The Diffusion of Enterprise Systems

The sample frame focused only on organisations that had implemented and used ES for at least a year. In this study, ES covered ERP, CRM, and SCM. ES are first implemented to integrate and manage information within an organisational boundary (ERP system). The ES subsequently evolves and expands beyond the organisational boundary to manage the relationships at the value-chain system level with customers (CRM system) and suppliers (SCM system). The latter two are known as the second wave of ES, or ERP II (Moller 2005). Table 8.1 provides the diffusion of the three ES across the different industries. Most of the respondents (88.8 per cent) have implemented an ERP as their basic ES. On the other hand, CRM (68.7 per cent) had been implemented in service-oriented industries that had large numbers of customers and high levels of customer interaction, such as those in the finance and banking, service, real estate, and trading sectors. A lesser proportion (58 per cent) of organisations used SCM.

Although SCM systems are not usually found in service-oriented industries such as banking, law firms and airlines, it can be seen from Table 8.1 that these organisations did implement SCM. Some feasible explanations for this result may come from the organisations' perceptions on how complex their supply chain is (e.g., number of suppliers), the efficiency against the cost of managing their supply chain activities, the structure of the organisations management (i.e., location of divisions, level of management), and the unique characteristics of the industry they are operating in. For example, an airline company is classified as a service industry. Airlines need SCM to manage their in-flight catering. Their SCM is complex because it is not only determined by the number of suppliers for different products, but also the characteristics of the business (landing in different locations requires different local suppliers).

Table 8.1 Diffusion of Enterprise Systems

Industry	Sample Distribution		Head Count of ES		
	Total	Per cent	ERP	CRM	SCM
Construction	7	3.9	6	5	3
Banking/Finance	23	12.8	17	17	6
Service	31	17.3	25	25	18
IT	6	3.4	3	4	3
Logistics	15	8.4	15	12	12
Manufacturing	45	25.1	44	30	30
Media	2	1.1	2	2	2
Mining	6	3.4	6	0	5
Real Estate	2	1.1	2	2	0
Retail	23	12.8	20	16	15
Telecommunications	2	1.1	2	2	2
Trading	5	2.8	5	4	2
Transportation	3	1.7	3	1	2
Utility	9	5.0	9	3	5
Other	0	0.0	0	0	0
Total	179	100	159	123	105

The sampling criteria ensured that all respondents must have used at least one of the three ES for at least a year. Table 8.2 captures the longevity of ES use. Eighty-six per cent, 58 per cent, and 53 per cent of the respondents had used ERP, CRM and SCM respectively for more than a year. The respondents had many years experience with ERP systems, with 68 per cent using it for at least five years, compared to the percentages that had use CRM (27 per cent) and SCM (27 per cent).

Table 8.2 The Longevity of Enterprise System Use

Period of ES use	ERP		CRM		SCM	
	Number	Per cent	Number	Per cent	Number	Per cent
Not available	8	4.5	42	23.5	61	34.1
Less than 1 year	5	2.8	19	10.6	11	6.1
1~2 years	15	8.4	32	17.9	24	13.4
3~4 years	16	8.9	23	12.8	20	11.2
5~10 years	53	29.6	33	18.4	31	17.3
More than 10 years	70	39.1	16	8.9	19	10.6
Missing	12	6.7	14	7.8	13	7.3
Grand total	179	100	179	100	179	100

8.2.2 The Agility of Organisations versus Environmental Volatility

Respondents were asked to rate the importance of agility to their business as well their agility performance. The respondents' perception of their OA performance (calculated as a mean) and their level of customer, operational and partnering agility, grouped by industry, are reported in Table 8.3. From Table 8.3, the average score of the OA levels of all organisation was 2.51. The mean customer agility, operational agility, and partnering agility scores were 3.01, 2.31 and 2.20, respectively. Examining specific dimensions of agility, the mean customer agility of a particular industry is always higher than that of its operational and partnering agility. This shows that Australian and New Zealand organisations perform relatively better in customer agility (e.g., 'constantly look for opportunities to add value to our customers', 'quickly respond to customers' needs', 'continuously anticipate our customers' needs') than in operational agility (e.g., 'quickly shorten the time-to-market of new products and/or services', 'easily redesign existing business processes', and 'easily create new business processes') and partnering (e.g., 'easily switch between suppliers', 'easily change the type of resources that organisations acquire from their suppliers'). Overall, all respondents showed poor agility performances, with mean agility scores below 3.0. In particular, companies operating in the construction, mining, real estate, trading and utility sectors had the lowest agility scores, at 2.08, 1.73, 2.00, 2.18 and 2.26, respectively. Companies in the retail, logistics and manufacturing and services sectors showed agility values slightly above the average, with values of 2.77, 2.71, 2.51 and 2.64, respectively. Finance, IT, and media industries showed agility levels below the average, with values of 2.42, 2.44 and 2.35, respectively.

On the other hand, the ED level of the respondents was 2.98, indicating a medium level of turbulence in the business environment. This implies that Australian and New Zealand organisations operate in an environment that is characterised by a low-medium rate of new product innovation, speed of technological change, changing customer preferences, and regulatory changes. In particular, the finance, IT, and media industries showed a relatively higher competitive and turbulent market, with medium to high values of ED. The ED value of the media sector was 3.5 on a scale of 5, while that of the finance/banking and IT/IS industries was 3.21 and 3.0, respectively. Companies operating in the construction, mining, real estate, trading and utility sectors had ED values of 2.21, 2.46, 2.13, 2.45 and 2.56, respectively. Compared to the overall sample, the ED of these industries is relatively low, further emphasising that these industries have low levels of customer, technological, innovation and regulatory changes in their business environment, or at least that is how the survey respondents perceived their operating environments. Of all the industries, the telecommunications and transportation industries were the two whose companies maintained a relatively high level of agility (2.9 and 2.8, respectively). Telecommunications is also the most turbulent industry, with an ED score of 3.63, while transportation is considered a stable business environment, with an ED score of 2.83.

Table 8.3 Organisational Agility Level by Industry

Industry	Mean Values				
	Customer Agility	Operational Agility	Partner Agility	OA	ED
Construction (CONS)	2.8	1.6	1.8	2.1	2.2
Finance/Banking (FINA)	3.0	2.3	1.9	2.4	3.2
IT(IT IS)	3.0	2.6	1.7	2.4	3.0
Logistics (LOGI)	3.1	2.7	2.3	2.7	3.1
Manufacturing (MANU)	3.0	2.4	2.2	2.5	3.0
Media (MEDI)	2.6	1.9	2.5	2.4	3.5
Mining (MINE)	2.2	1.4	1.6	1.7	2.5
Real Estate (REAL)	2.8	1.7	1.5	2.0	2.1
Retail (RETA)	3.1	2.7	2.5	2.8	3.2
Service (SERV)	3.1	2.3	2.5	2.6	3.1
Telecommunication (TELC)	3.4	2.8	2.4	2.9	3.6
Trading (TRAD)	2.8	2.4	1.5	2.2	2.5
Transportation (TRANS)	3.4	2.5	2.6	2.8	2.8
Utility (UTIL)	2.8	1.7	2.3	2.3	2.6
Average	3.0	2.3	2.2	2.5	3.0

The scatter plot in Figure 8.1 shows the positions of the industries in an agility-ED matrix with ED on the X-axis and OA on the Y-axis. The two lines that run parallel to the vertical and horizontal axes from the middle points (3) of the scales segregate the matrix into four quadrants. Quadrant 1 occupies the upper right corner of the matrix, indicating that the ED and OA levels are high. The organisations of the industries in this region excel in agility. Quadrant 2 occupies the lower right corner of the matrix, demonstrating high ED levels but low agility levels. Organisations that fall into this quadrant require improvement in agility to fulfil the requirements of their competitive business environments. Quadrant 3 lies at the lower left corner of the matrix, indicating low levels of ED and OA. Since the business environment here is considered stable, organisations operating in these industries can consider being agile as a low priority. The forth quadrant, at the upper left corner of the matrix, indicates the industries that fall into the category of low levels of ED but high levels of agility.

The green line that links the minimum OA and ED levels (i.e., point (1,1) and the point of the maximum OA ED levels segregates the OA-ED matrix into two equal sections. The industries that fall in the area above the green line perform agility better than the requirements of their environments, that is relative to the dynamism of their business environments, while the industries that fall in the area below the green are below the requirements relative to their more turbulent business environments. The industries that fall on the line operate at an agility level appropriate for the requirements of their business environment.

Based on Figure 8.1, with the exception of the transportation industry, all other industries in Australia and New Zealand fall below the green line on the matrix, indicating that the organisations in these industries are operating at agility levels below those expected from a business environment perspective.

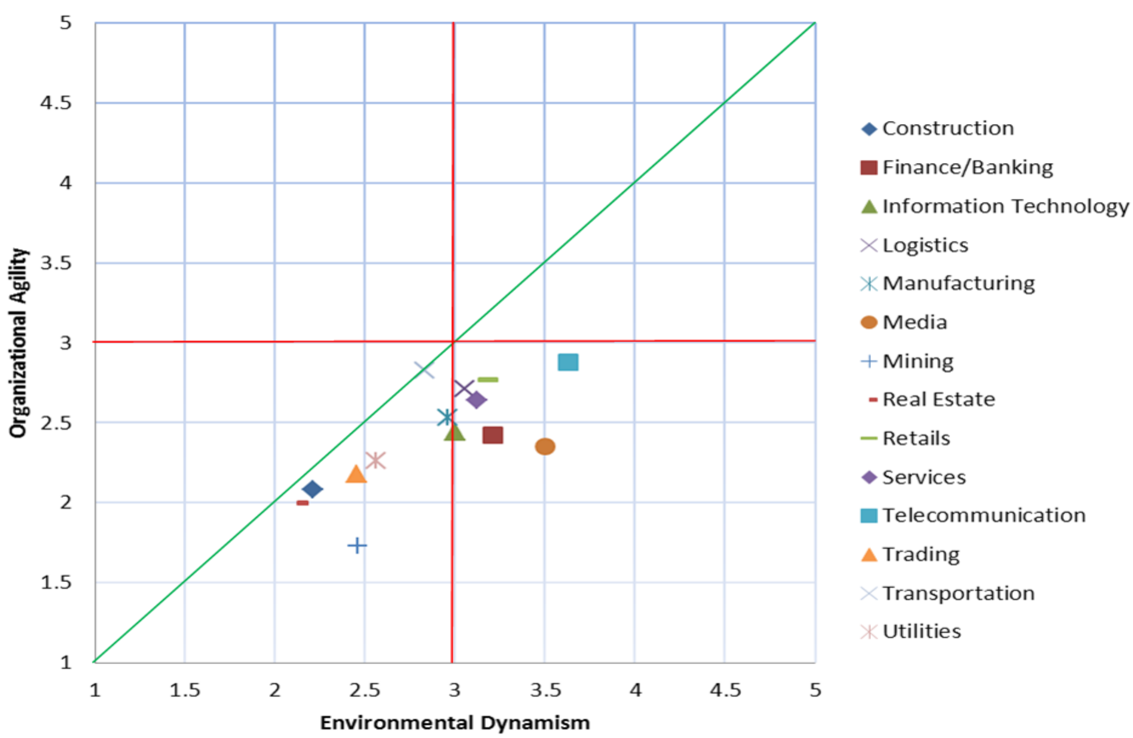


Figure 8.1 Positions of Australian and New Zealand Industries in an Organisational Agility-Environmental Dynamism Matrix

The above findings on agility performance and ED imply that although the sample organisations operating in some of the industries have low agility levels, the relatively stable business environment in their respective industries lessens the severity of the impact of not being flexible and adaptable. From an economic point of view, some of the industries (construction, mining, real estate, trading and utility) are known as oligopolistic market forms, with small number of competitors in the market and high barriers to entry (Rothschild 1947). The discrepancy between the agility levels and the ED values shows a large gap between agility needs and agility readiness (Oosterhout et al. 2006) in the media, finance and IT/IS sectors, while the gap is narrower in the retail, logistics, manufacturing and services sectors.

8.2.3 Enterprise System Competence and Enterprise System-enabled Sensing and Responding Capabilities

The purpose of this section is to examine the extent of the ES-based constructs among Australian and New Zealand organisations. The variables that were developed to measure ESC and ESS and ESR capabilities were discussed in Chapter 4. These variables were measured on a five-point Likert scale. Table 8.4 provides an overview (mean values) of the extent of the ES competences.

Table 8.4 Overview of Enterprise System Competence and Capabilities

Industry	ES-enabled Capability		ES Competence				
			Technical	Human and Managerial			Functional
	Sensing	Responding		Human	Managerial	Vendor	
Construction	3.00	2.64	2.25	3.60	2.95	3.43	3.53
Finance/Banking	3.24	3.22	2.99	3.92	3.54	3.43	3.69
IT	3.18	3.14	3.69	3.80	4.11	3.67	3.47
Logistics	3.25	3.36	3.18	4.01	3.82	3.73	3.73
Manufacturing	3.26	3.21	3.11	3.84	3.55	3.57	3.94
Media	2.20	2.33	2.56	3.90	3.00	2.25	3.65
Mining	3.22	3.36	2.88	3.83	3.17	3.75	4.07
Real Estate	3.70	3.42	3.13	3.80	4.17	3.75	4.08
Retail	3.61	3.43	3.09	3.90	3.68	3.65	4.19
Service	3.24	3.01	2.98	3.64	3.63	3.71	3.79
Telecommunications	3.75	3.08	3.38	3.70	4.00	4.00	4.39
Trading	3.80	3.60	3.45	4.44	4.47	3.50	3.76
Transportation	3.47	3.56	3.79	3.20	3.78	3.83	3.33
Utility	3.52	3.11	2.90	3.60	3.63	3.94	4.02
Average	3.32	3.20	3.06	3.82	3.62	3.62	3.86

The results in Table 8.4 reveal that all competences and capabilities are reasonably developed. In particular, the ES functional, human and managerial competences are relatively well-developed. This is particularly noteworthy, as ESF has not been well researched in prior studies. Australian and New Zealand organisations appear to utilise the functionalities of ES in digitising their sensing and responding processes and developing ESS capabilities (3.32) and ESR capabilities (3.20). On the other hand, the IT technical competence of the surveyed organisations had the lowest mean value. To further investigate these competencies and capabilities, the industry and the effects of company size on the constructs are examined and discussed below.

Figure 8.2 illustrates the differences in competencies and capabilities as a result of different company size. Except for EST, medium-size Australian and New Zealand companies have slightly lower levels of ESC and ES-enabled sensing and responding capabilities than their larger counterparts. This could be due to the fact that to support large organisations, IT infrastructure is more complex because of the high degree of specialisation and complexity in organisational structure. Furthermore, the integration of data and business processes and the compatibility of applications across the platforms are likely to be far more complex in large organisations. Moreover, for large organisations, the coverage of the ES across various business units would result in special add-ons from different providers. Large organisations recruit the best vendors and need support from several vendors who may not be able to provide comprehensive solutions that work compatibly with each other.

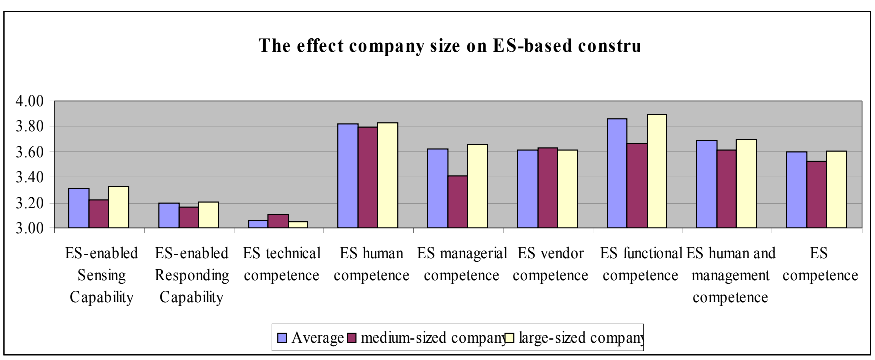


Figure 8.2 Effect of Company Size

However, the difference in ESC and capabilities between the large and medium-sized companies was not statistically significant. The results of an independent sample t-test of the company size are displayed in Table 8.5 below.

Table 8.5 Independent Sample T-test on Company Size

ES Competence	Mean	Mean Large Size	Mean Medium Size	T	P	Mean Difference	Std. Error
ESS	3.32	3.33	3.22	-0.69	0.49	-0.11	0.16
ESR	3.20	3.20	3.17	-0.25	0.80	-0.04	0.15
EST	3.06	3.05	3.11	0.29	0.77	0.05	0.19
ESH	3.82	3.82	3.79	-0.22	0.83	-0.03	0.15
ESM	3.62	3.66	3.41	-1.36	0.18	-0.25	0.18
ESV	3.62	3.61	3.63	0.11	0.91	0.02	0.19
ESF	3.86	3.89	3.66	-1.78	**0.08**	-0.23	0.13

The independent sample t-tests revealed that, excluding ESF where competence was impacted by size ($p<0.1$), none of the other constructs (EST, ESH, ESM, ESV and ESS and ESR capabilities) showed a statistically significant difference between large and small organisations. The significant difference between the large and medium-sized organisations in ESF may be possibly explained by the fact that large organisations may implement ES more comprehensively due to their larger budget for IT investment than that of the medium organisations, or because large organisations often have more complex business operations that requires relatively more standardised and complete IS to support them than do medium-sized organisations.

In summary, Australian and New Zealand organisations have high levels of ESF and ESHM, and moderate levels of EST and ESS and ESR capabilities. Furthermore, Australian and New Zealand organisations demonstrate better ESS capabilities than their ESR capabilities. By industry, although the media sector has a fairly good ESF, this industry has the lowest values of ESHM, EST and ESS and ESR capabilities of all the industries. ESF is influenced by the company size: large organisations have higher levels of ESF than medium-sized companies.

8.3 OVERVIEW OF THE RELATIONSHIP BETWEEN ENTERPRISE SYSTEMS AND ORGANISATIONAL AGILITY

Over the last decade, more attention has been paid to the role of IT and IS in organisational performance. Faced with challenges from a highly turbulent business environment, contemporary organisations have looked into agility as a new capability and success indicator to respond to changes and uncertainty and to achieve high levels of organisational performance (Goldman et al. 1995; Gunasekaran 1999; Mathiassen & Pries-Heje 2006). Likewise, OA is emerging as the topic of interest in IS research in order to understand the effects of IT/IS on agility. Yet, the IS literature is still dominated by conceptual research (Overby et al. 2006; Sambamurthy et al. 2003; Sherehiy et al. 2007) and contradictory claims. While some view the role of IS on OA as a facilitator (Fink & Neumann 2007; Sambamurthy et al. 2003; Tallon 2008), others consider it as an inhibitor (Newell et al. 2007; Seo & Paz 2008). Of the limited number of empirical studies available that have investigated IS-related agility antecedents (Tallon 2008; Bhatt et al. 2010, Fink & Neumann 2007, 2008; Zain et al. 2005), nearly all work on the assumption of a direct relationship between IS-related factors and OA. Changes in the business environment come from various sources, causing organisations to have distinctive ways of responding to changes. OA, an organisations' ability to sense and respond to changes, can be developed from various areas. Hence, it is viewed as having polymorphous aspects (Lee et al. 2007). In this context, simply viewing the direct relationship between IS and OA constrains the understanding of how IS supports the polymorphous aspects of OA. This means there is a limited understanding of the underlying mechanisms and associated conditions of IS-enabled OA.

Moreover, previous IS studies on OA have proposed IS-related constructs that are too broad and abstract to provide implications for practitioners (Tan et al. 2009). As such, the IS artefact these studies refer to is generically defined. On the other hand, although ES such as ERP, CRM and SCM are the most representative IS in organisations due to their comprehensiveness and prevalence, except where anecdotally mentioned as examples or cases (Sambamurthy et al. 2006; Mithas et al. 2007; Raschke 2010), their role in achieving agility remains under-researched. ES, although classified as one type of IS implemented in organisations and thereby inheriting common IS characteristics, have unique features that differentiate them from legacy IS (e.g., expert IS, decision support systems, transaction processing systems). ES have been found to provide benefits to organisational performance. However, the literature on ES is still dominated by ES implementation issues rather than post-implementation issues such as ES effects on OA (Moon 2007).

From the gaps in the literature discussed in Chapter 1, Section 1.3, this study has provided a framework to explain how and why ES can be exploited to enable an organisation to achieve a high level of agility. First, five competences of ES were identified: technical, human, managerial, vendor and functional competence. Then, drawing from DCT and process-based theory, this study has introduced two distinctive types of higher order ES dynamic capabilities: ESS and ESR capabilities as the missing link between ESC and OA. In addition to the direct relationship between ESC and OA that has been recognised in the previous literature, this study suggests that these two distinctive capabilities leverage ESC to achieve OA.

The framework proposed in the current research was tested with data obtained from 179 Australian and New Zealand organisations from various industries that have implemented and used ES. The results from structural model validation support the model proposed in this study. Overall, the theoretical framework explains 42.1 per cent of the variance of OA, 44.9 per cent of the variance of ESS and 51.7 per cent of the variance of ESR capability. All these explanatory powers satisfy the criteria set for good models (Chin 1998, p. 323). While the research findings show a direct relationship between ESC and OA (β=0.309, $p<0.01$), the framework proposed in the research that theorises an indirect relationship between ES and OA has a better explanatory power (R^2 indirect=0.421>R^2 direct=0.301), suggesting its value in explaining how OA can be achieved out of the available ESC.

A search of the IS literature produced no other published empirical research that has the same nomological structure; that is, independent and dependent variables linking ESC, ES-enabled sensing and responding capabilities and OA. Therefore, the research reported in this thesis can be considered as one of the first studies to conceptualise and empirically examine a research framework demonstrating why and how ES can be exploited to make organisations agile. Nevertheless, to position the result of the study within the existing IS research, the results were compared to related, if not similar, IS studies. Table 8.6 illustrates the results of the comparison of the variance explained for the agility construct. As Table 8.6 reveals, the variance explained by prior empirical studies of OA in the IS literature ranges from 21.8 per cent to 36.7 per cent. The variance explained by the current study falls above the norms set up by the existing IS studies.

Table 8.6 Comparison of Variance Explained

Reference	Dependent Variable	Findings	Variance Explained (per cent)
Tallon 2008		Both managerial and technical IT capabilities have a positive impact on agility, although ED did not uniformly translate into greater agility.	36.7
Lee et al. 2009	Operational agility	IT service competence formed by IT service infrastructure, standardised application platform, and IT service management skills is a significant driving force for a firm's agile operations	25.4
Lee et al. 2011	Strategic agility	IT infrastructure and IT strategic planning skills support a firm's strategic level agility	21.8

The literature review presented in Chapter 2 has introduced three views of ES and IS on OA: the facilitating, inhibiting and neutral views. The overall findings from this study are consistent with the argument that advocates viewing IS in general, and ES in particular, as a facilitator of OA (Tallon 2008; Sambamurthy et al. 2003; Overby et al. 2006; Lee et al. 2011; Bhatt et al. 2010; Goodhue 2010). The two fundamental attributes of OA are sensing and responding (Overby et al. 2006; Roberts 2011; Sambamurthy et al. 2003). However, three different views have been taken in examining the relationship between sensing and responding and agility (Seo & Paz 2008; Sambamurthy et al. 2003; Overby et al. 2006) (see Chapter 1.2). The framework proposed and validated in the current research shares Seo and Paz's (2008) and Sambamurthy et al.'s (2003) views that sensing and responding are separate from, and reside outside of, the domain of agility.

The results of this study show that ES has both direct and indirect impacts on OA. The higher explanatory power of the model suggesting an indirect impact of ESC on OA via the mediation effects of ESS and ESR capability over the model suggesting a direct impact of ESC on OA implies that ES have more impact on OA when they are exploited in sensing and responding processes than when they are not.

These research results are aligned with the findings from previous studies that the strategic use of IS competence can positively influence OA (Tallon 2008; Bhatt et al. 2010; Fink & Neumann 2007). Although most ES vendors, such as SAP and Oracle, are selling ES as a way to improve agility (Seethamraju 2009; Tallon 2008), the current research calls attention to the fact that agility is not entirely dependent on ES functions and technical features. Specifically, the current research suggests that to achieve agility out of ES, organisations need to build post-implementation ES technical, human, management, vendor and functional competences and develop their ability to exploit these competences to develop dynamic ES-enabled sensing and responding capabilities. In contrast to Carr's (2003) prediction that IT would become a commodity and therefore carries no strategic value, this research provides empirical evidence that regardless of the prevalence of ES, developing ESC and capabilities is essential to support OA, hence providing strategic value to organisations. Organisations are likely to differ in building these competences, which will affect the strategic value they can attain. IS such as ES evolve after their implementation through system upgrades (Srivardhana & Pawlowski 2007), thus ESC need to be maintained and developed.

8.4 ENTERPRISE SYSTEM-ENABLED SENSING AND RESPONDING CAPABILITIES AND ORGANISATIONAL AGILITY

This research study initially hypothesised that two dynamic capabilities, ESS and ESR, are the missing links from the previous literature in explaining how ESC enables OA. The effects of ES-enabled sensing and responding capabilities on OA have been theorised in several aspects: (1) the direct influence of ESS capability on OA; (2) the direct influence of ESR capability on OA; (3) the impact of the alignment between ES-enabled sensing and responding capability on OA; and (4) the mediating role of ESR capability on the relationship between ESS capability and OA.

8.4.1 The Direct Influence of Enterprise System-enabled Sensing Capability on Organisational Agility

In the current research, ESS capability was hypothesised to directly contribute to OA. Figure 8.3 illustrates a descriptive analysis on ESS capability, which measures the extent to which respondents' organisations use their ES to either facilitate or inhibit their ability to quickly and efficiently sense changes from their business environments. Less than one third of organisations considered that ES inhibited their sensing capabilities. In particular, the majority of the organisations indicated that ES facilitated or significantly facilitated their ability to empower end users for taking actions in business operations (64.8 per cent); examine trends in the data for industry foresight (59.2 per cent); interpret business intelligence for different management levels (i.e., strategic level, operational level) (53.6 per cent); notify of important changes in the business environment by analysing key performance indicators (52.5 per cent); and develop real time visibility of demand in the supply chain (52.5 per cent). These measures indicate the dimensions for interpreting and analysing information regarding organisational sensing capability. Hence, from these results, it is evident that majority of organisations consider that their ES facilitate their organisations' ability to interpret and analyse information. A few organisations reported that their ES helped them to capture as well as distribute business intelligence in regards to changes in their organisations' surroundings.

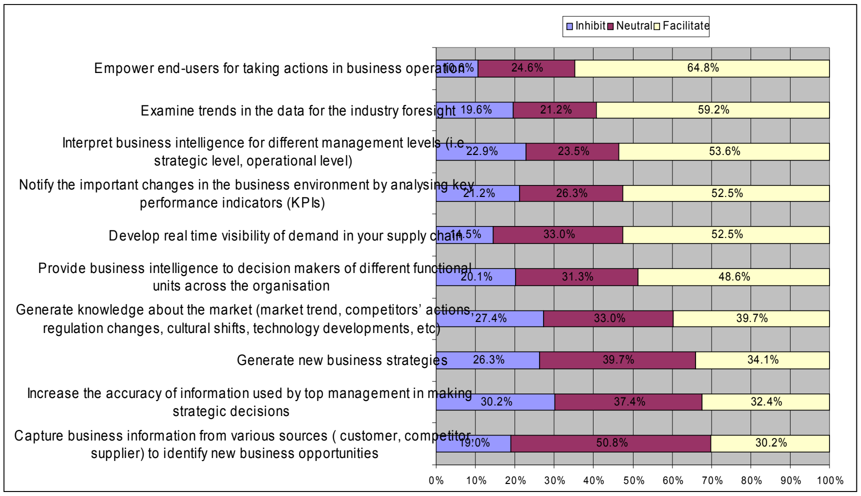


Figure 8.3 Enterprise System-enabled Sensing Capability

The results of the structural model validation in presented in Section 7.2 of Chapter 7 provide further evidence to support the results of the descriptive analysis. In more detail, the correlation between ESS and OA is positive and significant ($r=0.470$, $p<0.01$). Hypothesis testing indicated that ESS has a significant and positive effect on OA ($\beta=0.290$, $p<0.01$). Therefore, hypothesis H1 [*Organisations that use ES (such as ERP, CRM and SCM) in building and renewing their sensing capabilities are more likely to become highly agile*] was supported at the 99 per cent confidence interval.

On the basis of the above descriptive and structural analysis, the use of ES to sense changes in the business environment will eventually enable OA. This result is in agreement with prior studies on the positive impact of ES on OA (Gattiker et al. 2005; Goodhue et al. 2009; Overby et al. 2006; Sambamurthy et al. 2003; Seethamraju & Seethamraju 2009). However, it does not support the argument that ES inhibits OA (Newell et al. 2007; Ni et al. 2002). In particular, the finding validates the conceptual claim of Overby et al. (2006) that sensing is an essential component of OA and ESS capability is positively related to the level of OA. It also validates the argument of David et al. (2003) that ES enables sensing capability by offering data accessing throughout the entire range of organisational activities. In particular, the results of the hypothesis testing confirm Sambamurthy et al.'s

(2003) conceptual argument that the digitisation of knowledge and business processes will generate OA. This means that the assimilation of ES in organisations provides knowledge reach by providing business intelligence to decision makers within different functional units across the organisation, and knowledge richness via interpreting business intelligence for different management levels.

Additionally, the results add more empirical evidence to Goodhue et al.'s (2009) case study finding that ES enables agility by providing data analytic capabilities to access and interpret non-standard data. The result also confirms Coltman's (2007) finding that the functionality of CRM can enable organisations to develop proactive rather than reactive market sensing. Furthermore, the results reveal that organisations are using their ES to notify them of important changes in the business environment by analysing key performance indicators. Hence, this supports Oosterhout et al.'s (2006) argument that agile organisations are required to be able to quickly filter information for potential changes that may have significant magnitude to decision makers.

Therefore, this result of the hypothesis testing is consistent with the previous literature on the IT-enabled capability perspective (Tanriverdi 2005), which argues that IT capability acts as an enabler of higher order organisational capability in the organisation rather than as a higher order organisational capability itself. For example, Powell and Dent-Micallef (1997) find that IT resources have no effect on firm performance unless managers use IT to leverage complementary human and business resources such as flexible culture and supplier relationships.

The ES-enabled capabilities focus on the actual use of ES in providing a strategic view (predictability, environmental trends) of the business environment rather than basic knowledge management activities. The findings of this study suggest that organisations that excel in using ES in capturing business intelligence from various sources, interpreting it for different management levels, and providing it to decision makers within different functional units across the organisation while prioritising the most important changes in the business environment, will be able to quickly sense changes in their business environment. Specifically, the use of ES to increase the accuracy of the information used by top management in making strategic decisions, generating new business strategies and empowering end users for taking actions in business operations emphasises the critical role of ES in providing a comprehensive view of ES on the business environment at the strategic level.

The findings on the positive impact of ESS on OA represent an original contribution to the ES and OA literature. In particular, the research extends the ES literature by providing a validated construct of ESS capability. Furthermore, the scales of ESS provide the initial dimensions of the reach and richness of digitised business processes and knowledge which were vaguely specified by Sambamurthy et al. (2003). In particular, knowledge reach is reflected through the extent of capturing of information from various sources and under different formats, while knowledge richness is reflected through the extent of information generated from ES could be used at different strategic levels.

Instead of examining ES as the direct source of OA, through the finding of the positive relationship between ESS capability and its positive relationship with OA, this research emphasises the use of ES to enable certain capabilities (i.e., sensing capability). Thus, the interaction of ES and OA is not static. It varies according to how ES is manoeuvred in the business process of sensing the environment to provide a dynamic ESS capability.

Based on the measures of ESS, the findings signify which business processes that ES practitioners need to focus on in their ES development on in order to achieve OA. The results show that organisations can use their ES to facilitate sensing business changes through capturing business information from various sources (customers, competitors, suppliers) to identify new business opportunities and generate knowledge about the market (market trends, competitors' actions, regulatory changes, cultural shifts, technology developments). Thus, to enable agility, ES contribution must be examined at the strategic level.

8.4.2 The Direct Influence of Enterprise System-enabled Responding Capability on Organisational Agility

ESR capability was hypothesised to directly contribute to OA. From the measurement model validation in presented in Section 7.2, ESR capability was operationalised as the extent to which ES assimilation can either facilitate or inhibit six fundamental business activities in responding to changes from an organisations' business environment, as demonstrated in Figure 8.4.

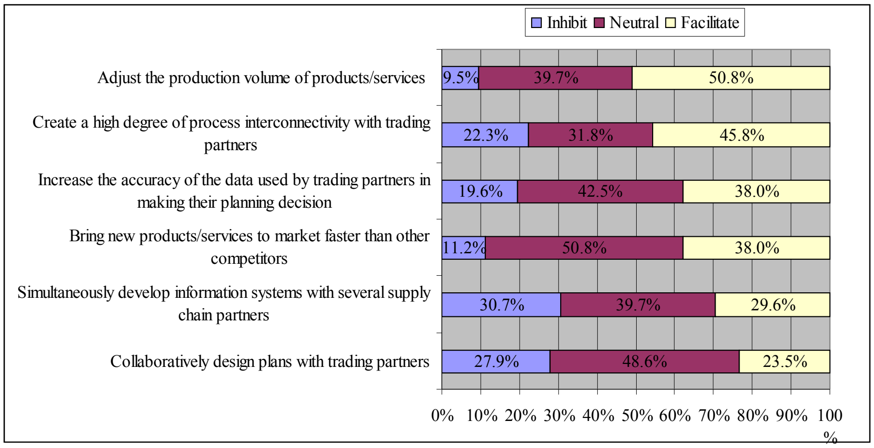


Figure 8.4 Enterprise System-enabled Responding Capability

Figure 8.4 shows mixed results. However, the experience of the majority of the organisations tended to support either the neutral or facilitating view of the role of ES in enabling organisational responding processes. In particular, ES facilitates or significantly facilitates organisational ability to adjust the production volume of products/service (50.8 per cent) and create a high degree of process interconnectivity with trading partners (45.8 per cent). Further, there are also more organisations that view their ES's role as facilitating rather than inhibiting their ability to increase the accuracy of the data used by trading partners in making their planning decision (38.0 per cent facilitating versus 19.6 per cent inhibiting), and bringing new products/services to market faster than other competitors (38 per cent facilitating versus 11.2 per cent inhibiting). The results illustrated in Figure 8.4 show that respondents are more or less evenly divided on the role of ES to simultaneously develop IS with several supply chain partners (29.6 per cent facilitating versus 30.7 per cent inhibiting), and in collaboratively designing plans with trading partners (27.9 per cent facilitating, 23.5 per cent inhibiting).

The above descriptive findings imply that in the respondents' organisations, the use of ES tends to facilitate internal operational business activities when responding to changes rather than external collaborations with business partners when responding to changes.

In terms of structural relationships, the correlation between ESR and OA is positive and significant ($r=0.505$, $p<0.01$). The structural model validation in presented in Section 7.2 shows a significant and positive impact of ESR on OA ($\beta=0.033$, $p<0.01$), indicating that hypothesis H2 [*Organisations that use ES (such as ERP, CRM and SCM) in building and reviewing their responding capabilities are more likely to become highly agile*] is supported.

This finding is consistent with Overby et al.'s (2006) argument on the positive impact of responding capability on OA. Along with the findings on sensing capability identified in the previous section, this result substantiates the conceptual argument of the previous literature on two essential components—sensing and responding—of OA (Dove 2005; Haeckel 1999; Overby et al. 2006; Sambamurthy et al. 2003; Seo & Paz 2008).

This result shows that organisations that have built ES-enabled capabilities and embedded them in their processes to bring new products or services to market faster than other competitors and to adjust the production volume of their products or services are able to quickly respond to market needs and shorten their time to market. Thus, this finding validates the conceptual argument of Christopher et al. (2004) that a short time to market, the ability to scale up (or down) quickly and the rapid incorporation of consumer preferences into the design process are typical characteristics of responsiveness.

Further, the findings provide empirical evidence for Sambamurthy et al.'s (2003) and Overby et al.'s (2006) propositions that the digitisation of knowledge and knowledge richness enables OA. Specifically, organisations that have used their ES to create high degrees of process interconnectivity, both internally and with their trading partners, can advance their operational and partnering agility. This is consistent with the results of Nazir and Pinsonneault (2012), Gattiker et al.(2005) and Malhotra et al. (2007), who claim that internal electronic integration is essential for an organisation's responding capability. However, this finding expands these studies by showing that internal integration and process coupling between internal units is not enough to address changes. Electronic integration is required to cover business activities that are associated with external business partners.

Overall, this result indicates that organisations will be able to quickly respond to change if they can use their ES to bring new products/services to market faster than other competitors, adjust the production volume of their products/services, create a high degree of process interconnectivity with their trading partners and collaboratively plan with them while at the same time increasing the accuracy of the data used by their trading partners and simultaneously developing a shared IS. The literature suggests that ES could be used in facilitating inter-organisational collaborations with business partners in the planning, design and execution of business processes, IS and strategies. However, Australian and New Zealand organisations currently use ES in digitising internal business operational activities, and hence, there is a gap between the potential of ES and the exploitation of ES.

The research findings provide certain implications for both practice and theory. In particular, the construct ESR capability was defined and its measures developed for the first time in this study, which is an original contribution to the ES and OA literature. ESR capability emphasises the integration of data, process, and strategy internally as well as with business partners. Integration with business partners is required for each of these aspects hence this finding implies that in order to achieve agility, organisations are required to develop an ES that allows their interaction with external business partners, such as CRM for customers or SCM for suppliers. ES that focus on internal organisational operations, such as ERP, will only marginally contribute to OA in terms of supporting the integration of internal processes.

The finding of a positive impact of ESR capability on OA provides several implications for ES practitioners for the management of their organisation's ES-enabled capabilities. Organisations should institute a greater focus on assimilating ES into critical business processes that are required to respond to changes. It is not the ES, but the actual use of the ES, that create an ESR capability that is dynamic, renewable, and reconfigurable. The literature suggests that ES should be used to assist organisations in their collaborations with business partners when responding to changes via collaborative plan design, integrated information and business processes as well as shared IS. However, Australian and New

Zealand organisations currently use ES in digitising internal business operational activities. Hence, this gap may open future directions for ES practitioners in Australia and New Zealand in terms of managing ES that actively enable outward spanning in collaborations with external business partners.

8.4.3 The Alignment between Enterprise System-enabled Sensing and Responding Capabilities

The alignment between ES-enabled sensing and responding capability is hypothesised to positively affect OA. The alignment between ESS and ESR is presented as a latent variable generated by applying the product indicator approach. Each measurement item of this latent variable is measured as the product of an item of ESS and an item of ESR (see Section 3.6). Thus, the measure of the alignment of ESS and ESR is mathematically constructed.

The hypothesis testing suggested a significant and positive influence of the alignment of ESS and ESR on OA (β=0.377, $p<0.05$). Hence, hypothesis H3 (*Better alignment of ESS and ESR capabilities is more likely to lead to higher OA*) is supported at the 95 per cent significant interval.

The findings of the hypothesis testing is consistent with the argument of Overby et al. (2006) and Roberts and Grover (2012) that an organisation with aligned sensing and responding capabilities will not waste their capabilities and perform at a higher level of agility than a non-aligned organisation. Nevertheless, in contrast to Overby et al.'s (2006) and Roberts and Grover's (2012) perspective on the alignment of ESS and ESR from the matching approach, this research takes the moderating approach. However, in Overby et al.'s (2006) and Roberts and Grover's (2012) studies, sensing and responding were considered as two dimensions of OA and were not separated from the OA construct domain. The current study treated ESS and ESR capabilities as antecedents of OA. Thus the hypothesis result is an original empirical finding.

These results represent an original contribution to the development and management of ES in supporting organisations operating in a turbulent business environment. Specifically, the findings imply that ES practitioners need to align the ESS and ESR capabilities of their organisations at both the operational and the strategic levels. For example, new investment in ES functionalities that support organisations in capturing business data (e.g., implementing a web portal for a CRM system that allows customers to directly interact with the organisation via the Internet), must be reviewed in advance to examine if the existing ES functionality for responding capability will run compatibly with the new business model (e.g., direct and immediate data retrieval from the customer master database).

8.4.4 The Mediating Role of Enterprise System-enabled Responding Capability on the Relationship between Enterprise System-enabled Sensing Capability and Organisational Agility

This study theorised ESS capability has an indirect influence on OA that is subject to the mediating influence of ESR capability. The results of the data analysis presented in Chapter 7 show a moderate to strong relationship (β=0.405, $p<0.01$) between ESS and ESR capabilities. Therefore, hypothesis 4 (*Higher ESS capability is more likely to lead to higher ESR capability*) is supported.

This finding is in line with the findings of Roberts and Grover (2012) that responding capability mediates the influence of sensing capability on organisational performance. However, Roberts and Grover's (2012) study focuses only on customer agility instead of OA, and sensing and responding capability instead of ES-enabled sensing and responding capabilities.

The research findings on the mediating impact of ESR on the relationship between ESS and OA confirms the findings of previous research that organisations sense opportunities and then respond accordingly based on a process (Haeckel 1999; Seo & Paz 2008). Therefore, ESS capability and ESR capability are interdependent, in that high levels of ESS capability will result in high levels of ESR capability. This result further reinforces the assumption that ESS capability should not be developed separately from ESR capability.

In summary, the findings on relationship between ESS and ESR in terms of the moderation and mediation perspectives that were discussed above imply that researchers should consider the alignment of sensing and responding capabilities from multiple perspectives when researching agility-related issues. Likewise, managers should acknowledge the importance of alignment of ES-enabled sensing and responding capabilities on the overall organisational performance, especially in their design strategies for ES development.

8.5 ENTERPRISE SYSTEM COMPETENCE, ENTERPRISE SYSTEM-ENABLED SENSING AND RESPONDING CAPABILITIES AND ORGANISATIONAL AGILITY

Most of the studies in the literature on ESC in particular, and IS competence in general, only focus on the availability and performance of the ES or IS resources (i.e., flexible IT infrastructure) to gauge the potential of the ES or IS contribution to an organisation. This research theorises that ESC is a higher order construct that can be formed from five subdomains. In this section, the findings of the hypotheses related to ESC as a second order construct (Section 8.5.1) and in terms of its five subdomains (Sections 8.5.2–8.5.6) are discussed.

8.5.1 Enterprise System Competence and Enterprise System-enabled Sensing and Responding Capabilities

The current research hypothesises that ESC contributes to the ability of organisations to sense, as well as to respond to, changes in their business environment. Based on insights from the literature, ESC was initially constructed to consist of three subconstructs: EST, ESHM and ESF. Through the validation of the measurement model, the construct ESHM was identified as a second-order construct that comprises three first-order constructs: ESH, ESM and ESV. All of these constructs were argued to be reflective variables.

The correlations between ESC and ESS ($r=0.670$, $p<0.01$) and ESR ($r=0.654$, $p<0.01$) are strong, positive and significant, predicting a relationship between them. The result of the structural model testing in presented in Section 7.2.1 of Chapter 7 indicated that ESC has a strong and significant impact on ESS capability ($\beta=0.670$, $p<0.01$) and ESR capability ($\beta=0.382$, $p<0.01$).

Thus, hypothesis H5 (*ESC is positively related to ESS capability*) and hypothesis H6 (*ESC is positively related to ESR capability*) are supported. Further, the testing of the rival model (Model C, see Section 7.3) offers support to the direct hypothesis between ESC and OA ($\beta=0.549$, $p<0.01$). However, the findings show that the indirect impact of ESS on OA through ESS and ESR ($R^2=0.421$) is greater than the direct impact of ESC ($R^2=0.301$). This result confirms the advantage of the proposed framework in comparison to the model generated from rival theories explaining the relationship between ES and OA. The results confirm the theorisation of indirect influence of ESC on OA via the two constructs ESS and ESR.

These results represent an original contribution to the literature. The prior IS literature has conceptually and empirically argued for a direct and positive relationship between ES and OA. Shang and Seddon (2002) claim that one of the benefits of ES is in enabling organisational flexibility. Seethamraju and Seethamraju (2009) argue that ES integration promotes business process agility, while Gattiker et al. (2005) state that built-in flexibility, process and data integration, together with consultant knowledge supports OA. Furthermore, at the IT level, Tallon (2008) finds a direct relationship of technical IT capabilities and managerial IT capabilities with business process agility. Weill et al. (2002) suggests that strategic agility benefits from IT infrastructure. However, all these studies investigate the direct relationship between ES-related resources and OA. On the contrary, this study tests the indirect relationship between ESC and OA. Thus, the research's findings identify two new dynamic capabilities in converting ESC to OA. The results also imply that ESC seems to contribute more to organisational sensing capability than to responding capability, with a standardised path coefficient of ESC and ESS ($r=0.670$, $p<0.01$) that is greater than the that of ESC and ESR ($r=0.382$, $p<0.01$). This is not surprising, given that most of the respondents in the sample (see Sections 8.4.1 and 8.4.2) use ES in digitising their sensing processes rather than their responding capabilities.

These findings imply that future research could examine how ES could facilitate both responding and sensing capabilities more extensively. The findings also validate the ES literature, which suggests that ES might contribute more to sensing capability than to responding capability. For instance, high technical integration in ES infrastructure causes ES systems to become too rigid for any future change, while data and process integration and powerful data capturing and analysis functionalities from ES play an important role in detecting changes (Seethamraju & Seethamraju 2009). Hence, this finding adds an initial stepping stone to the IS literature investigating specific roles of ES on organisational sensing and responding capabilities. Further, the findings imply that ESC must be leveraged into ESS and ESR to enable OA.

For practitioners, the findings imply that to advance OA, organisations must develop their EST, ESH, ESM, ESV and ESF competences and use them to generate ES-enabled sensing and responding capabilities.

8.5.2 Enterprise System Technical Competence and Enterprise System-enabled Sensing and Responding Capabilities

EST refers to the ability of ES technical infrastructure to deliver and support the rapid design, development and implementation of ES, and the ability to distribute any type of information across organisations. EST is hypothesised to have a direct positive effect on both ESS capability (Hypothesis 5a) and ESR capability (Hypothesis 6a). Figure 8.5 illustrates the extent to which Australian and New Zealand organisations exhibit EST.

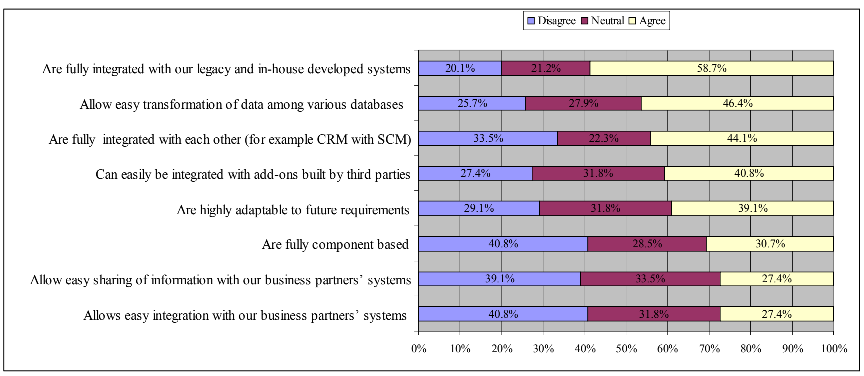


Figure 8.5 Enterprise System Technical Competence

From Figure 8.5, organisations agree that their ES: (1) are fully integrated with legacy and in-house developed systems (58.7 per cent); (2) allow easy transformation of data between various databases (46.4 per cent); (3) are fully integrated with each other (e.g., CRM with CRM) (44.1 per cent); (4) can easily be integrated with add-ons built in by third parties (40.8 per cent) and (4) are highly adaptable to future requirements (39.1 per cent). However, some EST, such as (1) the ES is fully component based; (2) easy sharing of information with business partners' systems and (3) easy integration with business partners' systems, are not widely developed. The results indicate that the respondents' organisations focus more on ES development towards integration and interconnectivity within organisational boundaries rather than expanding the ES technical scope to enable interaction with external business partners or having ES technical infrastructure which is change-ready. This will affect responding capability. Two fundamental qualities of EST are integration and adaptability (Sprott 2000; Stratman & Roth 2002). These descriptive results show that organisations seem to focus more on internal integration, while neglecting the development of adaptive and externally integrated ES technical infrastructure.

The correlations between EST and ESS ($r=0.657$, $p<0.01$) and ESR ($r=0.656$, $p<0.01$) were strong and significant, suggesting possible relationships between them. Further, the hypothesis testing showed a significant and positive direct impact of EST on ESS ($\beta=0.496$, $p<0.01$) and ESR ($\beta=0.367$, $p<0.01$). Therefore, Hypothesis 5a (*Organisations that have developed a high level of EST are more likely to exploit that competence in order to build their ESS capability*) and Hypothesis 6a (*Organisations that have developed a high level of EST are more likely to exploit that competence in order to build their ESR capability*) are supported at the 99 per cent confidence interval.

Based on the above descriptive and structural analyses, it was concluded that EST generates both ESS and ESR. These results extend the existing ES and IS studies such as those of Tallon (2008) and Fink and Neumann (2007) by suggesting an indirect relationship between EST and OA via mediation by ESS and ESR.

Furthermore, the results of the hypothesis testing confirm Desouza's (2006) conceptual argument that agile IS is required for OA. This result extends Goodhue et al.'s (2009) finding from a single case study that the ES technical infrastructure which allows data and process integration through 'easy transformation of data among various databases', 'fully integrated with legacy and in-house developed systems', 'fully integrated with each other' and 'integrated with add-ons built by third parties' enables organisation responsiveness to business changes. These finding extends Gattiker et al.'s (2005) result that the flexibility built into the ES is a source of agility. Certain changes to organisations may be well anticipated by ES designers. Thus, when change happens, simple reconfiguration of the ES can accommodate these changes.

Further, these findings show that integration of the systems, in terms of data and business processes, is crucial to developing the EST to enable ES-enabled sensing and responding capability to cope with business changes. Hence, these results expand Seethamraju and

Seethamraju's (2009) finding that vertical (integration between different hierarchical levels) and horizon integration (across the organisation) improve OA.

These findings show that EST that is 'fully component based' and 'highly adaptable to future requirements' can generate ESS and ESR capabilities. Hence, they supports Gebauer and Schober's (2006) findings that the IS must maintain its two dimension of ES flexibility-to-use and ES-flexibility-to-change to support business process changes by high levels of uncertainty.

EST, which generates ESS and ESR, allows integration within the organisation (with legacy and in-house system) as well as externally (with add-ons built in by third parties). This integration occurs at the dimensions of data and business processes. The second quality of EST that is needed to enable ESS and ESR is adaptability, which requires the system to have a flexible technical infrastructure to accommodate future changes.

The findings from the testing of Hypotheses 5a and 5b provide original contributions to the ES and OA literature. In particular, they imply that EST indirectly impacts OA through the mediation of ESS and EST. Thus, the findings provide suggestions to ES practitioners for ways to manage their organisations' EST that allows to it to be leveraged to generate ESS and ESR.

8.5.3 Enterprise System Human Competence and Enterprise System-enabled Sensing and Responding Capabilities

ESH is defined in this thesis as the competence of the IT staff who have both the technical and business knowledge to manage their ES and transfer that knowledge to end users. ESH is hypothesised to have a positive influence on both ESS capability (Hypothesis 5b) and ESR capability (Hypothesis 6b). The descriptive analysis displayed in Figure 8.6 indicates that the majority of respondents agree that their organisations have adequate knowledge and skills necessary for supporting their ES.

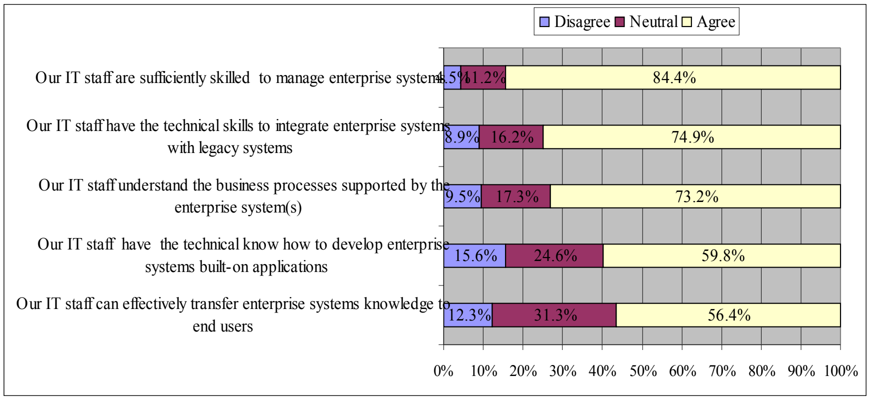


Figure 8.6 The Extent of Enterprise System Human Competence in Australia and New Zealand

The correlations between ESH and ESS capability ($r=0.308$, $p>0.1$) and ESR capability ($r=0.344$, $p>0.1$) predict a positive but not statistically significant relationship between ESH and ESS capability, and ESH and ESR capability.

Likewise, the structural analysis and hypothesis testing presented in Section 7.2, Chapter 7 showed a non-significant relationship between ESH and ESS capability ($\beta=-0.070$, $p>0.1$) as well as ESH and ESR capability ($\beta=0.048$, $p>0.1$). Therefore, Hypothesis 5b (*Organisations that have developed a high level of ESH are more likely to exploit that competence in order to build their ESS capability*) and Hypothesis 6b (*Organisations that have developed a high level of ESH are more likely to exploit that competence in order to build their ESR capability*) are not supported.

However, in the alternative model (Model E, Section 7.2, Chapter 7) that tests the direct relationship between ESC and OA, ESH has a positive and significant direct relationship with OA ($\beta=0.121$, $p<0.1$). Hence, improvement in ESH is a necessary condition for OA.

The ES and IS literature has explored the impact of ESH on agility. Specifically, Fink and Neumann (2007) have identified that IS personnel capability, consisting of business capability, behavioural capability and technical capability, impact on agility via the mediating role of the IT infrastructure capability. Tallon (2008) classifies IT skills as part of IT technical capability and states that they have a direct impact on business process agility. Hence, the results of this study confirm Fink and Neumann's (2007) and Tallon's (2008) research findings on the direct contribution of ES.

Hence, the findings of this study provide implications for ES and OA research, indicating that further exploration of the interactions between ESH and ES sensing and responding capabilities as well as other ES competences may be informative. The results from the testing of the alternative model (Model E) carry an implication for ES practitioners: to rapidly improve OA, they need to closely supervise and manage their ESH. For instance, organisations should provide frequent ES staff training to continuously update their knowledge and skills up to date.

8.5.4 Enterprise System Managerial Competence and Enterprise System-enabled Sensing and Responding Capabilities

ESM refers to the competence of strategic level management of ES that aligns ES development strategy in synchrony with business objectives. The current research hypothesises that ESM has a positive direct impact on ESS capability and ESR capability, as Hypothesis 5c and 6c, respectively.

Figure 8.7 below illustrates the descriptive analysis of ESM from the respondents' organisations.

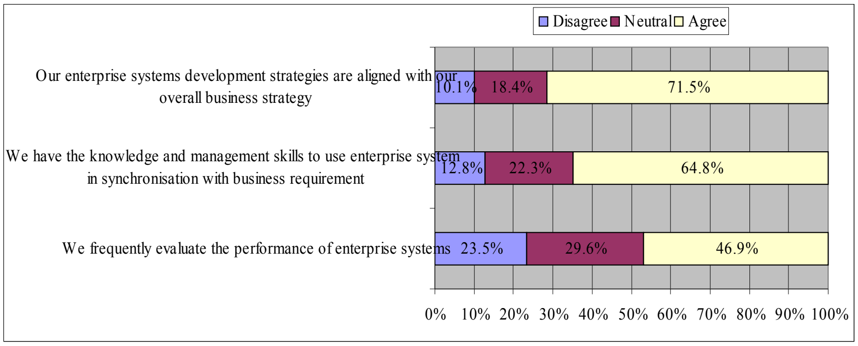


Figure 8.7 The Extent of Enterprise System Managerial Competence in Australia and New Zealand

The results show that the majority of organisations agree that they have adequate ESM necessary to develop ES. In particular, 71.5 per cent and 64.8 per cent of all organisations agree that their ES development strategies are aligned with their overall business strategy and they have the knowledge and management skills to use ES in synchrony with their business requirements. However, only 46.9 per cent of the respondents agree that their organisations frequently evaluate the performance of their ES.

The correlations between ESM and ESS capabilities ($r=0.474$, $p<0.05$) and ESR capability ($r=0.436$, $p<0.1$) predicted positive and significant relationships between ESM and ESS capability and ESM and ESR capability. The hypothesis testing indicated a positive and significant relationship between ESM and ESS capability ($\beta=0.181$, $p<0.01$), however a nonsignificant impact of ESM on ESR capability ($\beta=0.063$, $p>0.1$). Therefore, Hypothesis 5c (*Organisations that have developed a high level of ESM are more likely to exploit that competence in order to build their ESS capability*) is supported at the 99 per cent significance level. However, Hypothesis 6c (*Organisations that have developed a high level of ESM are more likely to exploit that competence in order to build their ESR capability*) is not supported.

The direct impact of ESM on OA was tested through the alternative model (Model E; see Chapter 7, Section 7.2). The result showed that ESM has a direct and significant impact on OA (β=0.274, p<0.01).

The findings of the above hypothesis testing suggest that an organisation's level of ESM contributes to OA both directly and indirectly through leveraging ES to sense business changes. This finding is consistent with the ES and IS literature on the contribution of ESM to OA (Galliers 2007; Tallon 2008; Tallon & Pinsonneault 2011). The finding concurs with Tallon's (2008) finding that managerial IT capability enables OA. However, it supports both an indirect impact on OA via ESS generation, in addition to a direct impact as suggested by Tallon (2008). One of the ESM competences emphasises the alignment of ES and business activities at both the operational and strategic levels. Tallon and Pinsonneault (2011) claim that ES–business alignment provides better sensing capability since the IT and business managers are more apt to sense changes and to build consensus around how best to react. Hence, the findings of the hypothesis testing support this claim and provide a more empirical base. Furthermore, the results also confirm Tallon and Pinsonneault's (2011) findings that strategic IT alignment enables OA.

The above discussion implies that ESM is important for the development of ESS capability, which in turn enables OA. Hence, the findings confirm the indirect impact of ESC on OA, which is the main focus of the thesis study. Furthermore, the findings imply to practitioners that to attain OA, organisations need to develop a high level of ESM. For that purpose, organisations need to ensure their ES function and its performance is in line with business requirements. Furthermore, the ES development strategies must be aligned with the organisation's business strategies.

8.5.5 Enterprise System Vendor Competence and Enterprise System-enabled Sensing and Responding Capabilities

One common view of ES (such as ERP) is as 'constraining and inflexible like cement highly flexible in the beginning but rigid later' (Davenport 2000, p. 16). Thus, organisations need to frequently maintain and upgrade their ES to sustain OA. ES system upgrades are bridged by ES vendors (Srivardhana & Pawlowski 2007). ESV competence emerged as a subdomain of the ESC construct during the instrument validation, which led to the formulation of Hypotheses 5d and 6d, which hypothesise that ESV directly and positively influences ESS and ESR, respectively.

ESV measures the technical know-how and the quality of vendors' support. Accordingly, 58.7 per cent of the respondents believe that their ES vendor's staff had the technical know-how to troubleshoot problems quickly. In addition, 66.5 per cent of the respondents believe that their ES vendor(s) provide continuous support to their organisation, including extended technical assistance, emergency maintenance updates, and special user training (see Figure 8.8). Further, the correlations between ESV and ES-enabled sensing and responding capabilities are 0.213 ($p>0.1$) and 0.290 ($p>0.1$), respectively. The correlation values are less than 0.3 and non-significant, indicating that there are no relationships between ESV and ESS capability, or between ESV and ESR capability.

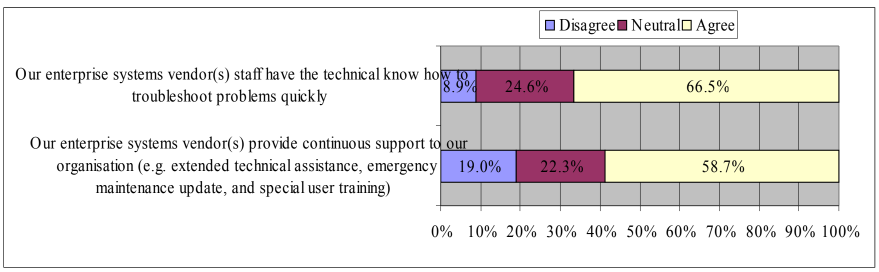


Figure 8.8 The Distribution of Enterprise System Vendor Competence

The structural model tests (Model B; Figure 7.2, Chapter 7) further confirm the results from the correlation testing. Specifically, the hypothesis testing indicated insignificant relationships between ESV and ESS capability (β= 0.041, $p>0.1$), and ESV and ESR capability (β=-0.063, $p>0.1$). The results show that ESV does not have an impact on ESS capability or ESR capability. Furthermore, Model E, which tests the direct relationship between the first order constructs of ESC and OA, shows that the relationship between ESV and OA is not statistically significant (β=-0.009, $p>0.1$).

On the basis of the above results, Hypothesis 5d (*Organisations that have developed a high level of ESV are more likely to exploit that competence in order to build their ESS capability*) and Hypothesis 6d (*Organisations that have developed a high level of ESV are more likely to exploit that competence in order to build their ESR capability*) are not supported. However, the correlation between ESV and EST is 0.353, which is greater than the minimum threshold of 0.3 (Hair et al. 2010) predicting a relationship between the two constructs. The strong correlation between ESV and EST suggest the possibility of a relationship between these two constructs.

Gattiker et al. (2005) claim that vendor-supplied software for special features, as well as third-party software vendor packages, are an important source of agility. The vendors and the third parties develop special purpose packages that give the customer base a much larger set of ‘options’ to choose from. Seethamraju and Seethamraju (2009) also state the claim of the ES vendors that their continuous updates of their software, released as versions, incorporate improvements in processes, technology and other management issues.

The finding on the testing of this hypothesis, therefore, imply that the relationship with ES vendors does not directly impact the capability of organisations to sense or respond to business changes. Instead, the results of the hypothesis testing predict a relationship between ESV and EST. Hence, ESV could enable OA through its complementary impact on other EST competences. Therefore, future research could focus on exploring the relationships between ESV competences and other ES competences and how these relationships impact OA.

8.5.6 Enterprise System Functional Competence and Enterprise System-enabled Sensing and Responding Capabilities

ESF refers to the scope of the ES in digitising the business processes of the organisation as well as the extent of use of the ES in the organisation’s activities. ESF is derived from Karimi’s (2009) research on ES scope. The scope of ES implementation is closely related to business process reach and richness, which refers to the scope of the digitisation of business processes in generating digital options as proposed by Sambamurthy et al (2003). ESF is hypothesised to influence ESS capability and ESR capability positively in Hypotheses 5e and 6e.

The descriptive analysis of ESF is illustrated in Figure 8.9. From the figure, 39.7 per cent of the respondents state that their ES has digitised their organisations’ business processes adequately, while 27.4 per cent of the respondents believe that their ES have been used to their full extent in performing their organisations’ business activities. The gap between the

ES functional scope and the extent of ES use implies that organisations have not fully exploited their ES.

In addition, the correlations between ESF and ES-enabled sensing and responding capabilities are 0.483 and 0.406, respectively, which is greater than 0.3 and thus predicts a relationship between ESF and ESS capability as well as between ESF and ESR capability.

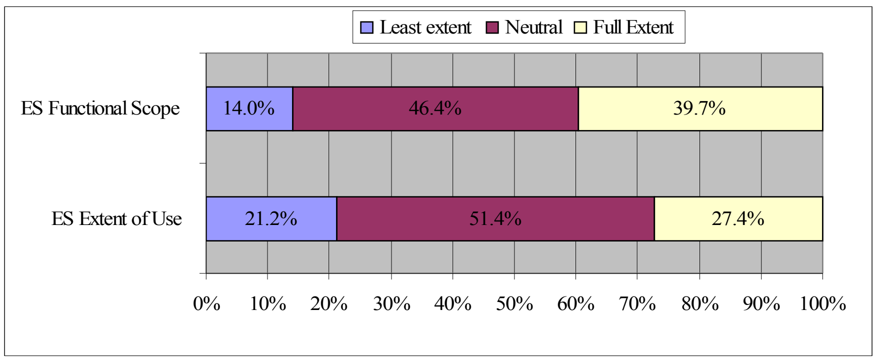


Figure 8.9 The Distribution of Enterprise System Functional Competence

Furthermore, the hypothesis testing showed a significant and positive direct impact of ESF on ESS capability (β=0.233, p<0.01). However, the impact of ESF on ESR capability was non-significant (β=0.061, p>0. 1). Therefore, Hypothesis 5e (*Organisations that have developed a high level of ESF are more likely to exploit that competence in order to build their ESS capability*) is supported at the 99 per cent confidence interval. However, Hypothesis 6e (*Organisations that have developed a high level of ESF are more likely to exploit that competence in order to build their ESR capability*) is rejected.

On the basis of the above discussion, the findings of Hypothesis 5e on the positive contribution of ESF to ESS capability not only confirm Sambamurthy et al.'s (2003) argument on the impact of digital options on OA, but also extend this claim by providing an empirical example of how digital options can be measured in the ES domain. Specifically, in the ES context, digitised process reach is measured by ES functional scope, and digitised process richness is measured by the extent of use of the ES.

The finding adds more evidence to Gattiker et al.'s (2005) case study showing that there are strategic benefits to adopting ES more widely. ES functional scope indicates how widely ES is implemented, and is positively related to ESS capability, which in turn is positively related to OA. Hence, one of the strategic benefits of ES functional scope is OA. Furthermore, ES functional scope indicates the breadth of horizontal integration, which refers to the interconnection between various departments or functions within an organisation. Seethamraju and Seethamraju (2009) claim that horizontal integration of processes and information contributes to improvement in process speed while compromising process flexibility. On the other hand, the findings of Hypothesis 6e reveal that ESF does not positively influence ESR capability. Hence, these findings concur with Seethamraju and Seethamraju's (2009) findings that the horizontal integration inhibits ESR capability.

These results imply that organisations need to develop ESF when developing OA. In particular, the results suggest that organisations must have adequate levels of business processes digitised through ES implementation. Moreover, organisations also need to ensure that they use ES to perform business activities whenever an ES is available.

8.6. ENVIRONMENTAL DYNAMISM, ENTERPRISE SYSTEM COMPETENCE, ENTERPRISE SYSTEM-ENABLED SENSING AND RESPONDING AND ORGANISATIONAL AGILITY

This research emphasises that environment is a critical factor that impacts every organisational activity. This is particularly the case in the context of OA research with regard to how organisations can perform better than their competitors in turbulent and uncertain business environments. The dynamism of the environment plays a role as a boundary condition that controls the proposed framework. This research has proposed that organisations operating in rapidly changing business environment will require a higher level of agility as compared to organisations operating in stable industries. Thus, Hypothesis 7 that states '*Organisations that operate in fast changing environments where product shelf life is short are more likely to develop high ESC and high ES-enabled sensing and responding capability than those that operate in a relatively stable environment'* was proposed. This hypothesis was then decomposed into nine subpropositions to evaluate the impact of the environment as a control factor in the framework (See Chapter 7, Section 7.2.3).

The descriptive analysis of ED is presented in Section 8.2.2 above. On average, the ED score based on the respondents' evaluations was 2.98 suggesting a medium turbulent environment. The results of the hypothesis testing were displayed in Table 7.12, Chapter 7. Only three of the nine subhypotheses were accepted (H7f, H7h, H7i). Hypothesis 7f proposes that ED is positively related to OA, indicating that organisations operating in more dynamic and turbulent business environments show higher levels of OA. This research finding supports the theory that dynamism factors can influence the level of agility required in by organisation (i.e., organisations operating in a stable industry with predictable changes will require different levels of agility than those that operate in rapidly changing environments) (Oosterhout et al. 2006). The result of the tests of Hypotheses 7h and 7i indicate that in a dynamic business environment, organisations have a tendency to developing higher levels of ESR capability and ESC. This finding is consistent with the suggestions from the literature. For organisations operating in turbulent markets marked by rapid product obsolescence, short product lifecycles, high levels of customer turnover and price volatility, agility is a vital factor for a firm's survival (Oosterhout et al. 2006). In more stable settings, where product lifecycles, customer turnover and pricing are relatively predictable, agility and any underlying IT resources that foster increased flexibility are largely unnecessary (Sharifi & Zhang 1999).

While the literature regards the environment as a moderator of the link between IT capabilities and firm performance (Melville et al. 2004, 2007; Sambamurthy et al. 2003), this study is among the first studies to empirically test this claim. For Hypotheses, 7a, 7b, 7c, 7d and7e, it could be observed that ED had no impact on the link between ESC and ES-enabled sensing/responding capabilities, and between ES-enabled sensing/responding capabilities and OA, as well as the link between ESS and ESR capabilities. Hence, all organisations, regardless of the extent of their ED, are equally adept at using ES competences and capabilities in enabling agility. This finding contradicts the conceptual claim from the findings of Tallon (2008) which indicate that ED moderates the links between managerial IT as well as technical IT capabilities and OA.

The findings on the link between ED and other constructs of the current model provide some implication for both research and practice. Firstly, they confirm the conceptual claim in the literature that organisations operating in highly dynamic settings require higher levels of agility and higher level of resources and capabilities to attain that agility level. The current study indicates that organisations operating in dynamic environments in particular require high level of ESC and ESR capability. For practice, this result implies that organisations need to allocate more support to developing their ES technical, human, managerial, vendor and functional competences and leveraging these competencies to achieve ESR capability and eventually improve their agility. Secondly, the findings do not support the moderating impact of ED on the link between the constructs of the framework. This may open an avenue for further research.

8.7 SUMMARY

This chapter has discussed the findings of the research and their implications. From the result of structural model validation in presented in Chapter 7, Model A (Section 7.2, Chapter 7) which structures ESC as a higher order construct was selected as the best model for discussion. The references to the results of the alternative models have helped to enrich the discussion.

The proposed theoretical framework explains 42.1 per cent of the variance in OA. This provides empirical evidence to explain the indirect impact of ES on OA. In more detail, ESC can be leveraged to generate ESS and ESR capabilities, which enable OA. In addition, the study also finds evidence of a positive and direct impact of the alignment of ESS and ESR capabilities on OA. Likewise, as initially hypothesised, ESS capability is found to positively influence ESR capability. However, the study does not find any support for the hypotheses that suggest a moderating influence of ED on the relationship between the constructs of the models. Instead, the study provides further evidence to support the claim that organisations operating in more dynamic settings require higher levels of OA, ESR capability and ESC.

The roles of the five types ESC (EST, ESH, ESM, ESV and ESF) in the model were further investigated and discussed. The findings show that only EST has direct and positive relationships with both ESS and ESR capabilities. Both ESM and ESF have a direct influence on ESS, but no relationship with ESR. On the contrary, the study does not provide any evidence to indicate that ESH and ESV have any relationship with ESS and ESR.

The next chapter will outline the theoretical and managerial implications of the research findings. Furthermore, it identifies a number of limitations and provides suggestion for direction for further research.

CHAPTER 9: CONTRIBUTIONS, LIMITATIONS, AND CONCLUSION

9.1 INTRODUCTION

The purpose of this chapter is to provide a summary of the key findings and discuss how the research questions set at the start of this study have been addressed. The chapter then outlines the contributions of the research to both the academic and practitioner communities. Furthermore, it acknowledges a number of limitations and suggests directions for future research. Lastly, the chapter concludes with final remarks.

This chapter is organised into six sections. Section 9.2 revisits the research questions posed in Chapter 1 and summarises the steps followed to answer those questions, based on the suggestions identified in the research findings. Section 9.3 outlines the main contributions of this study to research, theory and practice. The limitations of the study and avenues for further research are outlined in Section 9.4. Finally, Section 9.5 provides a concise conclusion to the study.

9.2 RESEARCH QUESTIONS REVISITED

In a world of changing events such as globalisation, changing customer expectations, new technological inventions and many other factors, being agile in response to changes in the business environment becomes a critical attribute for contemporary businesses. Since the introduction of the concept of OA, it has received a great deal of attention from researchers in various areas. In IS research particularly, OA has become an increasingly important topic due to the reliance of organisational operations on the management of information resources. Nevertheless, several research gaps have been noted in the existing literature (see Section 1.3, Chapter 1) that limit our understanding of the role of IS in OA.

For example, only a few studies have attempted to open the metaphoric black box between IS and OA (Lee et al. 2007; Overby et al. 2006; Sambamurthy et al. 2003). However, of these studies, most have only provided conceptual frameworks that have not been tested empirically. Besides, the lack of clarity in defining the domain of IS-related constructs has led to contradictory conclusions in terms of whether IS either facilitate, inhibit or are inconsequential to OA. In addition, the IS constructs in the extant literature are too broad and abstract and are not related to any specific IS (Tan et al. 2010). This research study aimed to address these gaps by specifically focusing on the relationship between ES and OA and empirically testing the relationship.

To explain the impact of ES on OA, this study put forward the following as its main research question: '*Do ES enable OA?'* The facilitating view of ES on OA was taken in this research. To understand the mechanisms by which ES influences OA and determine the attributes of ES that contribute to OA, the main research question was further deconstructed into the following subresearch questions: '*what are the capabilities that can be developed from ES to advance OA? What are the ESC that contribute to the development of these capabilities?'*

Furthermore, since OA is linked to the business environment context, business environmental attributes might be one of the controlling factors that affect OA, ES-induced capabilities and ESC and the relationships between them. To understand the extent to which ED moderates OA and the relationships between agility, ES-induced capabilities and ESC, a third research question was formulated: '*Does the dynamism of a business environment moderates the process of transforming ES capabilities into OA?*' This section revisits the research questions and summarises the explanations.

9.2.1 Do Enterprise Systems Enable Organisational Agility?

The literature contains a number of studies on OA. In contrast, there is a dearth of studies that investigate the effect of ES on OA (Trinh-Phuong et al. 2010). ES studies mostly focus on the implementation problems of ES and descriptive survey of the effects of ES (Moon 2007). Hence, the post-implementation effect of ES on organisations, and specifically on OA, is still under-researched (Trinh-Phuong et al. 2010). There is a lack of research that theorises, tests, validates and evaluates the effect of ES on OA. To fill this gap, the main research question of this study was '*Do ES enable OA?*'

In a first step towards addressing this question, the literature on OA was reviewed. The variations in definitions of OA suggest that it can either be viewed as an organisational performance outcome or as an organisational capability (Sambamurthy et al. 2003). As one dimension of organisational performance, the importance and level of agility of different organisations can be compared. The strategic choice literature suggests that organisations perceive the importance of being agile to their organisational activity differently (Child 1997; Tallon & Pinsonneault 2011). This perception would affect the strategy they use when developing their resources. Organisations operating in more stable business environments will not require high levels of agility and thus will not invest in organisational resources (e.g., ES exploitation) for attaining OA. On the other hand, as a capability, OA specifies the potential for thriving in a turbulent business environment while not indicating the actual agility level of an organisation. In the current research, the performance view of OA was taken. Further, two capabilities, sensing and responding, were identified as critical capabilities that organisations must possess and develop to obtain agility.

From the review of the IS literature in general, and the ES literature in particular, presented in Chapter 2, it was identified that IS, including ES, can facilitate OA. Further, from the review of different perspectives on the determining factors of OA across various research fields, the DCT-based view was considered to be the most promising for conceptually linking ES resources and competencies with agile organisations (Sambamurthy et al. 2003; Teece 2007). Based on this theory, it was argued that an organisation that had implemented and used ES (e.g., ERP, CRM and SCM) could improve its agility level if it (1) had accumulated a stock of relevant ESC (including EST, ESHM and ESF) and (2) quickly and easily assimilated and mobilised its ES in the process of sensing changes in its business environment (such as gathering business intelligence from various sources, interpreting and analysing business intelligence, prioritising the business intelligence and providing it to various decision makers at different management levels) as well as responding to changes from the business environment (such as automating the organisation's production activity, easily setting the integration of business processes and data internally within the organisation and externally with its business partners).

This argument led to the development of a theoretical framework comprising seven main propositions and 19 subpropositions linking the different ES competences and ES-enabled capabilities to OA. The framework was empirically tested using data collected from 179 large organisations in Australia and New Zealand that had implemented and used ES (ERP, CRM and SCM) for at least a year.

The collected data were screened for missing data, outliers and other possible biases that could distort the results of the analysis (see Chapter 5). The measurement model underwent a two-stage rigorous validity and reliability verification process using SPSS and PLS (see Chapters 6 and 7). The structural model and hypothesis testing presented in Chapter 7 revealed that the proposed conceptual model explained 42.1 per cent of the variance in OA, indicating a large explanatory power (Cohen 1992). The findings revealed that ES positively facilitates OA in a number of ways.

First, ES allow organisations to quickly sense the business environment by capturing data from various sources, analyse the data into business intelligence from the overall environment and prioritise the most critical changes that have occurred or are going to occur. They also allow organisations to respond quickly and appropriately to the changes that have been identified by bringing new products and services to market faster, adjusting the production volume of products or services, creating a high degree of process interconnectivity with trading partners, increasing the accuracy of data used by trading partners, and the simultaneous development of IS with the trading partners.

Second, ES create the necessary conditions for the continuous development and deployment of skills, technologies, and functionalities necessary for enhancing OA. Furthermore, these conditions also contribute directly to the improvement of OA in terms of customers, partnering, and operations.

Hence, the research question ‘Do ES enables OA?’ can be answered in the affirmative. The results are novel because this study is one of the first to introduce the constructs ESS capability, ESR capability and ESC, theorise the relationship between these constructs and OA, and empirically test the claim that ESC, through the development of dynamic ESS and ESR capabilities, enables OA.

9.2.2 What are the Capabilities that can be Developed from Enterprise Systems to Advance Organisational Agility?

To address this subquestion, the DCT-based view and the PBV were drawn upon to identify two core capabilities of OA, namely, sensing and responding. On the basis of these theories, ESS and ESR were defined as the two capabilities that advance agility. These capabilities indicate the ability of an organisation to constantly integrate, build and reconfigure its ES and the business processes contained and enabled by these systems in sensing and responding to changes from business environment. The ES-enabled sensing and responding constructs were operationalised based on initial items generated from the literature (See Chapters 3 and 4). ESS capability reflects organisational ability to quickly capture, interpret, and analyse changing signals from the business environment. ESR capability reflects an organisation's ability to quickly respond to change via improving production and internal integration as well as external partnerships.

The initial measurement instrument was further purified and improved through a panel of expert survey and a pilot test with CIOs. The measurement model demonstrates adequate psychometric properties and fits the data, which indicates that the ESS and ESR capability constructs represent an important development for advancing research on how organisations make use of their ES when sensing and responding to changes. The structural model and hypothesis testing conducted in Chapter 7 revealed that ESS capability, ESR capability and the alignment between the two have significant and positive direct effects on OA. In particular, the link between the alignment of ESS capability and ESR capability is even stronger than the links between OA and each of these individual capabilities.

Table 9.1 summarises some, if not all, of the important capabilities that the surveyed organisations have developed to advance their agility.

Table 9.1 Important Capabilities of Enterprise System-induced Competences and Capabilities

Capability	Attributes Assimilate and use ES to:
ESS	Capture business information from various sources; generate knowledge about the market; interpret business intelligence for different management levels; notify of important changes in business environment; provide business intelligence to decision making across organisation; develop real time visibility of demand in the supply chain; examine trends in the data; increase accuracy of information used by top managers for making strategic decisions; empower end users for taking action in business operations
ESR	Bring new products/services to market faster than competitors; adjust the production volume; create a high degree of process interconnectivity with trading partners; collaboratively design plans with trading partners; increase the accuracy of the data used by training partners; simultaneously develop information with several supply chain partners

9.2.3 What are the Enterprise Systems Competences that Contribute to the Development of Enterprise System-enabled Sensing and Responding Capabilities?

ES-enabled sensing and responding capabilities can be developed from the integrating, building, and reconfiguring of ESC. This research specified ESC as an independent construct. Viewed from DCT, ESC represents the base resource to launch and build ES-enabled sensing and responding capabilities.

ESC was defined as the quality of the ES infrastructure that was developed after the adoption of the ES and during its ongoing use. Based on the IS competence literature (see Chapter 3), three ESC—EST, ESHM, and ESF—were identified and theorised as the factors that can be leveraged to generate ESS and ESR capabilities. The instrument validation process produced three subdomains for the ESHM construct. These subdomains were subsequently named ESH, ESV and ESM competences, resulting in five types of ES competencies.

The assessment of the structural model and the hypothesis testing performed in Chapter 7 revealed several positive direct effects of ESC on ESS and ESR. On the basis of these result (see Sections 8.2.1 and 8.2.2), Table 9.2 offers a summary.

Table 9.2 Summary of Enterprise System Competence Attributes that Contribute to Enterprise System-enabled Sensing and Responding Capabilities

ESC	Attributes that Contribute to:	
	ESS Capability	ESR Capability
Technical	Easy transformation of data between various databases	
	Fully integrated with legacy and in-house developed systems	
	Easily integrated with add-ons built by third parties	
	Integrated with each other (for example CRM with SCM)	
	Easy integration with business partners' systems	
	Easy sharing of information with business partners' systems	
	Fully component-based	
	Highly adaptable to future requirements	
Managerial	ES development strategies are aligned with overall business strategy	
	Frequently evaluate the performance of ES	
	Have the knowledge and management skills to use ES in synchrony with business requirements	
Functional	The extent that ES are used in business functions	
	The coverage of business processes by ES	

Further, through the testing of alternative models, the study shows that some of these ESC contribute directly to OA. For example, ESHM has a significant and positive direct influence on OA. In contrary, ESF shows a weak but significant positive direct impact on OA. However, EST shows no direct influence on OA. Therefore, one can argue that while EST and ESF indirectly influence OA by providing a basis for developing ESS and ESR capabilities, ESHM in addition to building sensing and responding capabilities can directly influence OA.

9.2.4 Does the Dynamism of a Business Environment Moderates the Process of Transforming Enterprise System Capabilities into Organisational Agility?

OA focuses on organisational performance in a turbulent business environment. Hence, variation in environmental factors moderates how OA can be built. Therefore, the final research question of this study is '*Does the dynamism of the business environment moderates the process of transforming ES capabilities into OA?*'

To address this question, the research investigated the moderating effect of environmental factors on the structural links between the constructs of the model. Specifically, this study identified ED as the critical environmental factor that moderates the structural relationships, as well as a factor that moderates the levels of ESS, ESR, OA and ESC. The study revealed that ED did not moderate any relationship in the structural model. Hence, the answer for the research question 'Do business environmental factors influence the process of transforming ES capabilities into OA?' can be found in this study. The dynamism of the environment does not moderate how ESC can be leveraged to develop ESS and ESR capabilities and hence enable OA. This result contrasts with previous findings reported in the literature (Tallon 2008) that environment factors, including ED, moderate the influence of managerial IT capability on business process agility. Thus, future research could further investigate the impact of environmental factors on how organisations mobilise their resources to improve agility. Expanding from the investigation of the moderating effect of ED on the relationship between the constructs in the model, this study also observed the impact of the environmental factor on the constructs, revealing that ED has a significant and strongly positive influence on OA. Organisations operating in more turbulent business environments show higher levels of OA.

9.3 CONTRIBUTION OF THE STUDY

Given the importance of OA in today's business world and the pervasiveness of ES, the lack of a framework that could explain the mechanism by which these two constructs are related is a critical issue. Hence, by developing and validating a theoretical model and the accompanying measurement instrument for assessing the effect of ES on OA, this study contributes to research, theory and practice in several ways. This section highlights these contributions.

9.3.1 Contribution to Academic Research and Theory

As far as the contributions of this research towards academic research and theory are concerned, academic research interested in the concept of ESC and OA will find merit in the work and underlying argument of this thesis in several aspects as the follows:

First, the thesis offers a comprehensive and deepened perspective on the existing discourses on IS/IT and ES-enabled OA. The researcher followed a systematic and rigorous approach to identify, select, and analyse the literature. The review represents an original contribution to IS research and can serve as a building block for future research on IS and OA.

Second, the thesis introduces two new constructs, ESS and ESR to IS and OA research. Drawing from Overby et al.'s (2006) idea of decomposing agility into its sensing and responding components, and Seo and Paz's (2008) idea of viewing sensing and responding as the two critical processes in pursuing OA, this research has defined the two constructs as the antecedents of OA. Hence, these two constructs, which were introduced in this research, could be observed separately. These constructs open up the 'black box' of IS capability in OA research. The research has provided both definitions of these constructs and measurement indicators for them, which advances theory.

Third, this research explicitly theorises the ES-related competencies that can be exploited to develop distinctive ES-enabled sensing and responding capabilities to advance OA in dynamic environments. This contributes to the current body of knowledge on the post-implementation benefits of ES, which is still under-researched. Following the suggestions of Orlikowski and Iacono (2001) and Alter (2008), the theorisation aligns with the findings from previous studies that strategic use of IS competence can positively influence organisational performance. Specifically, the current research suggests that if organisations possess ES technical, human, managerial, functional and vendor competences, they will create a digital platform to renew and develop unique ES-enabled sensing and responding capabilities to improve their agility. ES evolve after their implementation through system upgrades; thus ESC will continue to be maintained and developed.

Fourth, the research identifies a clear nomological structure linking ES with OA. From the literature, two views of OA were identified vis-à-vis the concepts of sensing and responding. While some (Overby et al. 2006) treat sensing and responding as components of agility, others take a process (Seo & Paz 2008) or capability (Sambamurthy et al. 2003) view and treat sensing and responding separately from agility. The framework proposed in the current article shares Seo and Paz's (2008) and Sambamurthy et al.'s (2003) views that sensing and responding are separate from, and reside outside of, the domain of agility. This position challenges Overby et al.'s (2006) view, which treats the two components as part of, and as located within, the scope of agility. While Sambamurthy et al. (2003) suggested the digitisation of business processes and knowledge would generate digital options, they did not specifically address the type of business processes and knowledge that contribute to digital options. This research extends Sambamurthy et al.'s (2003) framework by emphasising the digitisation of business processes involved in sensing and responding to changes and by theorising how this contributes to OA.

Fifth, through this research five competencies of ES; that is, technical, human, managerial, vendor and functional competences, were identified. Then, drawing from the DCT and process-based theories, in addition to the direct relationship between ESC and OA that has been recognised in the previous literature, two distinctive types of high order ES dynamic capabilities i.e., ESS capability and ESR capability and the alignment between the two as part of the nomology linking ESC and OA, were introduced. This structure clearly defines the notions of ES-enabled OA as distinct from those of Tan et al. (2010), Overby et al. (2006), and Sambamurthy et al. (2003). Thus, this study opens up the black box of the role of ES in OA. Using the capability hierarchy, the research delineated different levels of ES capabilities that could support practitioners in managing their ES resources and capabilities more effectively.

Sixth, the research has developed adequately validated instruments that can be used in future research. For example, the measures of ESS and ESR capabilities are original and have not been suggested in the previous literature. From the OA literature, the research drew on Sambamurthy et al.'s (2003) concept of OA and developed measures for customer agility, operational agility and partnering agility. The measures for the five ESC have been refined from the IS literature to capture the unique attributes of ES. The rigorous procedures followed in establishing the psychometric properties of these measures make them suitable for use in future research.

Seventh, the research empirically demonstrates the strategic value of IS in enhancing organisations' abilities to cope with changing business environments. The results of this study indicate that ES can improve both the sensing and responding capabilities to changes, thus enhancing OA levels. The developed model explains 42.1 per cent of the variance in the OA of the sample organisations, indicates a strong predictive power. Hence, this research contributes to the body of knowledge on the relationship between ES and OA in particular, and IS and OA in general. It also extends the existing ES research by suggesting OA as a new post-implementation ES benefit to organisational performance.

Eighth, the model proposed in the research is an original contribution. It addresses the IS research gap identified by Fink & Neumann (2007) and Lee et al. (2007) that there is a dearth of research exploring the internal mechanisms for deploying and utilising IT resources to enable OA. Further, this study's survey is a response to the call for empirical tests of the IS determinants of OA suggested by recent authors (Overby et al. 2006; Sambamurthy et al. 2003). As such, the research fills this missing link and provides a comprehensive view on how ES enables OA. In addition, it has integrated previous segregated insights from the DCT-based perspective of organisational ESC and the PBV into two essential components of OA, sensing and responding.

Ninth, the research provides empirical support to the application of DCT in measuring ES capabilities. This is a significant contribution because the majority of the current research looks at ES from the RBV. Thus, the study represents a first attempt at using DCT in conjunction with the PBV of OA to examine OA from different angles. As stated in Chapter 2, majority of the extant studies define OA as organisational capability; this research instead views OA as the outcome of capability-building process. Coupling the DCT-based view with the PBV of the two core dimensions of OA provided a logical rationale to theorise the linkage between ES-related constructs and OA.

Tenth, the study adds to the current body of knowledge on ES-post implementation benefits. The majority of ES research focus on implementation problems rather than the post-implementation issues.

9.3.2 Contribution to Practice

Organisation management is increasingly acknowledging the power of IS in organisational activities. IS can no longer be viewed as supporting services for a business. Instead, they have a leading role to play in strategic planning processes of any organisation (Willcocks & Lester 1999). Likewise, CIOs are no longer seen as passive senior executives but partners actively involved in the creation of business strategies. Therefore, the results of this study have several important implications for practitioners.

First, the study contributes to the management of ES as it reveals to ES practitioners that ES need not constrain agility. However, ESC must be developed and maintained not only through the technical platform and the knowledge and skills of the IT staff, but also through the management and use of the ES functionalities that have been implemented in the system as well as the relationship with vendors. This research makes it evident to ES practitioners that the development and deployment of ESC, ESS and ESR capabilities are important determinants of OA in a turbulent business environment.

Second, ESF is not only driven by the available business processes supported by the ES but also through from their use and the interaction of end users with the ES system.

Third, the alignment of sensing and responding activities has a substantial impact on the overall level of OA. However, organisations that operate in more dynamic environments may find it more difficult to align their sensing and responding activities. Therefore, organisations should integrate these two activities in their daily operations and strategic planning.

Fifth, this research provides the mechanism by which ESC enable OA, and the factors to take into consideration in ES practice. Understanding these mechanisms and factors will enable organisations to become more successful in managing their ES and improving their agility. Hence, the study provides practitioners with a different view on their ESC and capabilities and a benchmark against which they can measure the extent to which their use of ES enables their level of OA.

Sixth, using the capability hierarchy, the research delineated different levels of ES capabilities (i.e., ESC versus the ES-enabled capabilities), which will support practitioners in managing their ESC and capabilities more effectively. Specifically, the study recommends that practitioners ensure the availability of the following conditions for promoting ESC:

a) ES technical infrastructure should be fully integrated internally with other IS within the organisation (e.g., legacy systems) and externally with business partners' systems. It should be structured in a full component base, which allows easy modification, reconfiguration and adaptability to future changes.

b) The IT staff who work on the ES must have sufficient knowledge and skills to manage the ES systems, troubleshoot any problems that occur, and transfer their knowledge to ES end users.

c) IT top management must provide continuous strategic management and support to the ES through frequent evaluation of ES performance, and alignment of ES development strategies with the organisation's overall business strategies.

d) ES functions and add-ons should be put in place that can support business activities as well as future business requirements. The power of ES functions must be measured in their actual use in business activities rather than their availability alone.

e) The vendors of ES should capable of troubleshooting any problem that involves the ES, as well as providing continuous support to organisations.

Seven, the ESS and ESR capabilities, together with their corresponding validated measurement items, provide ES practitioners with guidance regarding the capabilities that must be developed and deployed within their organisations' ESC to attain agility. Further, practitioners should align their organisations' ESS and ESR capabilities to improve their organisations' agility. In particular, organisations should not only invest in building alignment capabilities, but also in the organising process in place to ensure that it can assimilate sensing information and structure the response.

Eight, the research findings emphasizes the importance of actual usage of the enterprise systems in business activities that involve organisational sensing and responding to the business environmental changes. Hence, this research provides a suggestion to the human resource management of organisations in term of training their staff on working with enterprise systems as their first choice in their daily activities. This practice should be part of the organisational culture.

Last, this research provides practitioners with a new perspective on measuring OA. This measurement method incorporates the organisation's agility capability and the importance of being agile to address the OA level relative to organisational strategic positioning. The method can be applied to regularly assess the requirements for agility and to incorporate the outcomes in designing appropriate strategy.

In summary, the findings of the study provide insights on how organisations can deploy OA out of their ES. This research reminds organisational executives that ES are not simply valuable platforms that help to enable communication internally and externally and to enable present and future business applications, but that ES are also a strategic component can contribute to OA.

9.4 LIMITATIONS OF THE STUDY AND AREAS FOR FURTHER RESEARCH

Despite the above contributions, the study has several limitations that need be noted and taken into consideration. These limitations may open avenues for further research in the future.

First, the cross-sectional design of the empirical study using a survey only allowed this research to take a static snapshot of the ESC, ES-enabled capabilities and OA of the sample organisations. With data collected at one point in time, it becomes a challenge to infer associations between the various constructs. This research does not illustrate what could possibly happen to the relationships between the constructs over the long term. Thus, the longitudinal impact of ESC, ES-enabled capabilities (i.e., sensing, responding) on OA cannot be observed. Likewise, the cross-sectional nature of this research makes it difficult to address the issue of how ES-enabled capabilities are created over time. Nevertheless, in this study, to avoid the possible problems due to time-lag factors, which assume that ES-enabled capabilities may require some time before their existence impacts on organisation performance, ESC and ES-enabled capabilities were measured after at least a year since the ES was first used by the sample organisations. A longitudinal research design could overcome this limitation. Possible changes in the relationships, if any, may be inferred by comparing the results between two points in time. Endeavours in this direction may potentially yield interesting results.

Second, the measurement instrument developed in this study was only tailored to large-sized organisations in Australia and New Zealand. The business environment may differ substantially between various geographical locations. This prevents the generalisation of this research's findings. Thus, replicating this research in different geographical areas is necessary since it will help to shed light on the question of whether this research's findings can be generalised.

Third, another limitation is the use of the same respondents for both the independent and dependent variables of the framework. To respond to the questions concerning ESC (the independent variables), respondents were required to have technical knowledge. In contrast, to respond to questions concerning OA (dependent variables), respondents were required to have business knowledge. Although statistically common method bias does not appear to threaten the validity of this study (see Chapter 6), a survey design that selects separate respondents for the independent and dependent variables may have reduced the potential for bias. Another limitation is the use of a single respondent for organisational-level data. For example, questions that measure ESC were related to the operational level. On the other hand, questions concerning OA required a view from a strategic level. Although the respondents appeared to possess sufficient knowledge, a multiple-respondent survey design would have strengthened the validity of the research results.

Fourth, in order to focus on explaining how the leveraging processes associated with ESC may generate ES-enabled capabilities to enable OA, this research did not include self-learning aspects within the framework. Organisations learn over time and through experience. Previous experiences help organisations deal with similar events in the future. Initial experiences with building ESS and ESR capabilities will influence the subsequent ESC. Sambamurthy et al. (2003) suggest that self-learning or feedback looping between the capability and outcome may be critical for sustainable OA. Therefore, the future research should investigate the reverse direction of the relationship between the constructs in the framework.

Fifth, each of the subconstructs of ESV and ESF consist of only two measurement items. They pass the minimum requirements for construct development (Hair et al. 2010) that a construct should at least be measured by two indicators as well as the construct validity tests (see Chapter 6). Nevertheless, further study to better develop these two constructs is necessary.

Sixth, among the three attributes of the business environment suggested in the literature, which include munificence, dynamism, and complexity, only ED was taken as a control variable in the framework proposed in this study. It is possible that some of the constructs interact with environmental variable sand change the composition of the relationships between the constructs proposed in this model. Hence, future research should test the other two dimensions of the business environment as the control variables of the structural relationships.

Seventh, to the best of the researcher's knowledge, this is first attempt to quantitatively measure ESS capability and ESR capability. Hence, different studies in this area will provide a more rigorous theoretical background and solidify the instrument. Additionally, since these two constructs went through rigorous instrument development process and validity tests, future research might independently use these two constructs to address the ability of ES in enabling sensing and responding to environment.

Eighth, another limitation is the exclusion of organisations from the survey due to the sampling frame employed (e.g., small organisations or organisations from the healthcare, agriculture, government and education industries). This research assumed that that these industries are stable and experience fewer changes in comparison to other industries. Thus, it is difficult to observe variation in agility of the organisations operating in these areas. Therefore, the findings of this study may apply to organisations from the industries that were excluded from the sample. Future studies could test the validity of the assumptions made around ED and size by testing the model developed in the current study in samples of small organisations as well as samples from the education, government and health sectors that have implemented ES.

Finally, future research could investigate how ES delivery is changing from product to software as a service and how the findings of this research change in that context.

9.5 FINAL CONCLUDING REMARKS

Since the early days of computerisation, there have been significant improvements in organisational IS ecosystems as organisations move from in-house developed systems to contemporary, off-the-shelf, enterprise-wide architectures and systems. ES that capture the most advanced developments of IT are becoming common fixtures in most organisations. However, how ES affect OA has been less researched and the existing research remains equivocal at best.

Working from the perspective that ES can positively contribute to OA, this thesis, through a process of theory-based model development and rigorous empirical investigation of the proposed model, has bridged significant research gaps and provided empirical evidence for, and insights into, the effect of ES on OA.

Overall, and directly addressing the research question posed at the beginning of the thesis, the theorisation and empirical results show that organisations can achieve agility out of their ES investment in three ways: (1) by developing ES technical, human, managerial, vendor, and functional competences; (2) by exploiting their ESC to build ES-enabled capabilities that digitise their key sensing and responding processes; and (3) when ES-enabled sensing and responding capabilities are aligned than when they are not, and when organisations operate in relatively turbulent environments.

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APPENDICES

Appendix 2.1. Definition Of Organisational Agility From The Information System Literature

Citation	Methodology	Definition	the "What" OA		The "How" OA			Speed	Environment Dynamism
			Fexibility	Adaptability	Sense	Response	Learning		
Breu et al. (2002)	Survey	Speed of action and ٦ flexibility to changes	X			X		X	X
(Sambamurthy et al. 2003) p.245	Conceptual	'The ability to detect opportunities for innovation and seize…opportunities by assembling requisite assets, knowledge and relationships'.			X		X		
Ahsan and Ngo-Ye (2005) p.415	Conceptual	'the ability of an organization to thrive in a continuously changing, unpredictable business	X			X		X	X

		environment’							
Lee et al. (2006) p. 50	Conceptual	‘A firm’s capability to flexibly and rapidly respond to environmental variations by assembling and (re)configuring requisite assets, knowledge, and business relationships’	X			X		X	X
Oosterhout et al. (2006) p. 132	Survey	‘The ability to swiftly and easily change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes.’	X				X	X	X
(Overby et al. 2006) p. 120	Conceptual	‘The ability of firms to sense environmental change and respond appropriately. Appropriate response is one that is supportive of a firm goal such as to increase			X	X		X	X

		market share, capture new customers, or fend of competition’							
Lyytinen and Rose (2006) p. 183	longitudinal multi-site case study	‘In the context of information system development (ISD), agility can be defined as an ISD organization’s ability to sense and respond swiftly to technical changes and new business opportunities.’			X	X		X	
Zain et al. (2005) p. 831	Survey	‘Agility is a response to the challenges posed by a business environment dominated by change and uncertainty. It involves a new way of doing business.’				X			X
Fink and Neumann (2007) p. 444	Survey	‘We define .. organizational agility as the ability to respond operationally and strategically to changes in	X					X	X

		the external environment..’							
Tallon (2008) p.21	Survey	‘..defined as the ease and speed with which firms can alter their processes to respond to threats or opportunities in their markets’				X		X	X
Seo and Paz (2008) p. 136	Conceptual	‘a set of processes that allows an organization to sense changes in the internal and external environment, respond efficiently and effectively in a timely and cost-effective manner, and learn from the experience to improve the competencies of the organization.’			X	X	X	X	X
Setia et al. (2008)	Case Study	An organization's ability to: (1) Discover new opportunities for competitive advantage; (2) Harness the		X	X	X		X	X

		existing knowledge, assets, and relationships to seize these opportunities; and (3) Adapt to sudden changes in business conditions							
Seethamraju and Seethamraju (2009) p.2		the ability to dynamically modify, reconfigure and/or deploy a business process (and its various components) to accommodate required and potential needs of the organisation				X		X	X
Tallon and Pinsonneault (2011)	Survey	The ability to detect and respond to opportunities and threats with ease, speed, and dexterity			X	X		X	X
Roberts and Grover (2012) p.580	Survey	"the degree to which a firm is able to sense and respond quickly to…. for innovation and competitive action"			X	X		X	X

Appendix 4.1. List of Initial Generated Items

Appendix 4.1(a). Initial Pool Of Items For Organisational Agility

ID	Item	Source
1	We constantly look for opportunities to add value to our customers	Ahsan and Ngo-Ye (2005), Tallon (2008) and Oosterhout et al. (2007)
2	Quickly respond to customers’ needs	
3	Quickly shorten the time–to-market of new products and/or services	
4	Continuously forecast our customers' needs	
5	Has a high level of interaction with our customer	
6	Quickly adapt to changes due to new regulations and technologies	
7	Easily redesign existing business processes	
8	Easily create new business processes	
9	Frequently launch new products/services	
10	Provide mass-customization of products and/or services	
11	Easily switch between suppliers	
12	Easily change the type of resources that we acquire from our suppliers	
13	Easily establish new supply chain partnership	

Appendix 4.1(b). Initial Pool Of Items For Enterprise System-Enabled Sensing Capability

ID	Item	Source
1	Capture business intelligence from various sources (customer, competitor, supplier)	Narver et al. (2004), Choo (2001) and Slater and Narver (2000)
2	Generate knowledge about the market (*market trend, competitors' actions, regulation changes, cultural shifts, technology developments, etc*)	
3	Interpret business intelligence for different management levels	
4	Analyse business intelligence in different formats (text, audio, video)	
5	Prioritise the most important changes in the business environment	
6	Provide business intelligence to decision makers of different functional units across the organisation	
7	Develop real time visibility of demand in your supply chain	
8	Develop alertness about the business environment	
9	Develop rich industry foresight	

Appendix 4.1(c). Initial Pool Of Items For Enterprise System-Enabled Responding Capability

ID	Item	Source
1	Quickly bring new products/services to market	Agarwal et al. (2007), Auramo et al. (2005), and Overby et al. (2006)
2	Quickly add more feature (s) to existing products/services	
3	Introduce new product/service faster than other competitors	
4	Easily adjust the volume of existing products/services	
5	Create a high degree of process interconnectivity with trading partners	
6	Simultaneously work on the same data with trading partners	
7	Collaboratively plan with trading partners	
8	Allow trading partners to work on your real data	
9	Increase the accuracy of the data used by trading partners	
10	Simultaneously develop information systems with several supply chain partners	
11	Simultaneously design business processes with several supply chain partners	
12	Increase the accuracy of information used by top management	
13	Create a high degree of intra-organisational process interconnectivity	
14	Adapt to radical market changes	
15	Empower employees for taking actions	
16	Resilient to radical changes	

Appendix 4.1(d). Initial Pool Of Items For Enterprise System Technical Competence

ID	Item	Source
1	Our enterprise systems allow easy transformation of data among various databases	(Fink & Neumann 2007; Ravichandran 2007; Stratman & Roth 2002)
2	Our enterprise systems are fully integrated with our legacy and in-house developed systems	
3	Our enterprise systems can easily be integrated with add-ons built by third parties	
4	Our enterprise systems are fully integrated with each other (*for example CRM system integrated with ERP system*)	
5	Our enterprise systems allow easy sharing of information with our business partners' systems	
6	Our enterprise systems architecture is fully component based	
7	Our enterprise systems architecture allows for easy integration with our business partners' systems	
8	We have developed a distributed and open enterprise systems integration platform	
9	Our enterprise systems adhere to our business requirements (*e.g. Sarbanes Oxley, BASEL II, GAAP*)	
10	Our enterprise systems architecture is highly adaptable to future changes (e.g.: government laws, tax standards)	
11	Our enterprise systems are fully integrated	
12	Our enterprise systems are adaptive	

Appendix 4.1(e). Initial Pool Of Items For Enterprise System Functional Competence

ID	Item	Source

	Financials (Financial Accounting, Management Accounting, Financial Supply Chain Management)	Karimi et al. (2007, 2009)
	Human Capital Management(HCM) (Employee Life-cycle management, employee transaction management, HCM Delivery, Workforce Deployment)	
	Operations (Procurement, Inventory & Warehouse Management, Manufacturing, Transportation, Sales Order Management, Customer Service)	
	Support (Lifecycle Data management, Program & Project Management, Quality Management, Enterprise Asset Management)	
ERP	Corporate Services (Travel Management, Environment Health & Safety, Incentive & Commission Management, Real Estate Management)	
	Marketing (customer targeting, pricing, marketing campaign management)	
	Sales (account management, sales lead management, customized sales recommendations for cross-selling and up-selling)	
	Service (customer service operation, customer data management, call centre operations, service knowledge database maintenance)	
CRM	Analytical CRM (customer value analysis, customer retention rate analysis, sales forecasting)	
SCM	Value Chain Planning (demand planning, collaborative planning, Inventory optimization, Production scheduling)	
	Execution (Order fulfilment, Procurement Management, Transportation Management, Warehouse Management, Manufacturing)	
	Collaboration (Supplier Network collaboration, Customer	

	Network Collaboration)	
	Visibility design and Analytics (Forecasting and replenishment)	

Appendix 4.1(f). Initial Pool Of Items For Enterprise System Human And Managerial Competence

ID	Item	Source
1	End users (managers, business staff) are sufficiently skilled to effectively use enterprise systems	Tallon (2008)
2	IT staff are sufficiently skilled to manage enterprise systems	
3	Our enterprise systems vendor(s) staff have the technical know how to troubleshoot problems quickly	
4	Our IT staff have the technical skills to integrate enterprise systems with legacy systems	
5	Our IT staff have the technical know how to develop enterprise systems built-on applications	
6	Our IT staff understand the business processes supported by the enterprise system(s)	
7	Our IT staff can effectively transfer enterprise systems knowledge to end users	
8	Our enterprise systems vendor(s) provide continuous support to our organisation (*e.g. extended technical assistance, emergency maintenance update, and special user training*)	
9	Organisational resources (financial, leadership, etc) can be easily mobilised when there is a need to change enterprise systems	
10	Our IT staff can work cooperatively in cross-functional teams with personnel from other departments	

11	Our enterprise systems development strategies are aligned with our overall business strategy	
12	We continuously evaluate the performance of enterprise systems	
13	We have the knowledge and management skills to use enterprise system in synchronisation with business requirement	

Appendix 4.1(g). Initial Pool Of Items For Environmental Dynamism

		Source
1	The rate of new product innovation	
2	The speed of technology changes related to our organisation's products and/or services	
3	The rate of change of customers' preferences	
4	The rate of change of industry regulations	
5	The speed of our products or services to be manufactured or sold	

Appendix 4.2. The Main Survey Questionnaire

Appendix 4.2(a). Main Survey Plain Language Statement

RMIT University

College of Business

School of Business Information Technology and Logistics

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

Project Title:

The role of enterprise systems in organisational agility: Exploring a causal model from a dynamic capability perspective

Investigators:

- Ms Thao Trinh-Phuong (PhD Scholar, School of Business Information Technology and Logistics, RMIT University, phuongthao.trinh@rmit.edu.au + (61 3) 9925 1476).
- Associate Professor Alemayehu Molla (Senior Supervisor, School of Business Information Technology and Logistics, RMIT University, alemayehu.molla@rmit.edu.au, + (61 3) 9925 5803).
- Dr. Konrad Peszynski (Second Supervisor, School of Business Information Technology and Logistics, RMIT University, konrad.peszynski@rmit.edu.au , + (61 3) 9925 1654).

Dear Sir/Madam,

You are invited to participate in a research project which is being conducted by RMIT University. This information sheet describes the project in straightforward language, or ‘plain English’. Please kindly read this information sheet carefully and understand its contents before deciding to participate. If you have any inquiries, feel free to contact any of the investigators named above.

This research is being conducted by Thao Trinh-Phuong, a PhD Scholar from the school of Business Information Technology and Logistics. The research is supervised by Associate Professor Alemayehu Molla and Dr. Konrad Peszynski of the school of BIT and Logistics, RMIT University. The aim of this research is to explore the impact of enterprise system on organisational agility. Enterprise systems refer to an integrated information management system that coordinates information across all enterprise functions. The three types of enterprise systems to be researched in this study are Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management System (SCM). Organisational agility is defined as the ability of organisations in sensing and responding to changes from their business environment. Our objective is to understand and provide recommendations that will enhance various uses of enterprise systems to support organisational performance in dynamic business environments. This project has been approved by the RMIT College of Business Human Research Advisory Network and adheres to the strict guidelines set by the Ethics Committee.

You have been approached to participate in this research project because you have been identified as a senior IT manager who has extensive knowledge of enterprise systems and their use in your organisation. Your contacts are provided by Fairfax Business Research database provider (http://www.fairfaxbr.com.au/). As a participant, you are required to fill in the survey questionnaire that will take approximately less than 20 minutes. The questions to be asked cover the issues related to the performance of your organisation in responding to changes, the quality of using enterprise system in the activities to capture, interpret, analyse and respond to changes, the competence of the people working on the enterprise system and technical aspects that support the enterprise system.

Your responses to the questions will be captured electronically. All information gathered during the course of this research, including your responses will be securely stored for period of five years in the School of Business Information Technology and Logistics, RMIT University and can only be accessed by the researchers. After five years, the data will be destroyed. Results published in academic journals and conferences will not include information that can potentially identify either you or your organisation. The participants will not be named or identified in any outcomes of this research. Any information provided by the participant would be safe guarded in accordance to the strict guidelines of the RMIT University Human Research Ethics guidelines.

There are no foreseeable risks associated with your participation in this research project. Your participation will assist the researcher and the wider information system community in providing insights pertaining to the impacts of enterprise system in organisational ability in responding to changes in turbulent business environments. The findings of the research will help organisation to better utilize enterprise systems, which are very large and crucial investments that change overall business activities. You might elect to receive a summary of the results of the study. In order to do so, you need to provide use with a contact address in the space provided on the questionnaire. Addresses collected in such a manner will only be used for disseminating the results and will be destroyed afterwards.

Your participation in this research is voluntary. As a participant, you have the right to (a) withdraw your participation at any time, (b) have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and that does not increase the risk for the participant, and (c) have any questions answered at any time. Any information that you provide can only be disclosed if 1) it is to protect the participant or others from harm; 2) a court order is produced; 3) with written permission from the participant.

As another option to the paper-based survey, this project will use an external site to create, collect and analyse data collected in a web-based survey format. The site we are using is Survey Monkey (http://www.surveymonkey.com). If you agree to participate in this survey, the responses you provide to the survey will be stored on a host server that is used by the researchers. No personal information will be collected in the survey so none will be stored as data. Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for a period of five (5) years. The data on the RMIT host server will then be deleted and expunged.

Due to the nature of data collection process, we do not require written consent from you. Please note that by completing and returning the survey, it is assumed that consent is given by you.

If you agree to participate, please proceed to the questionnaire enclosed in the letter or its web-based version at https://www.surveymonkey.com/s/organisationalagility

If you have any questions regarding this research, please kindly contact researcher Thao Trinh-Phuong,
Phone: + (61 3) 9925 1476, Mobile: +(61) 430502115, Email: phuongthao.trinh@rmit.edu.au
or the supervisors listed above.

Thank you for your participation in this research.

Yours Sincerely

Ms Thao Trinh-Phuong
School of Business Information Technology and Logistics
RMIT University
Level 17, Building 108, 239 Bourke Street, Melbourne, Australia, 3000

Any complaints about your participation in this project may be directed to the Secretary, Portfolio Human Research Ethics Sub Committee, Business Portfolio, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is +61 3 9925 5594 or email address rdu@rmit.edu.au. Details of the complaints procedure are available from the above address or http://www.rmit.edu.au/council/hrec

Appendix 4.2(b). Main Survey Questionnaire

RMIT UNIVERSITY

The Role of Enterprise Systems in Organisational Agility

This survey aims to investigate how enterprise systems such as Enterprise Resource Planning system (ERP), Customer Relationship Management system (CRM), Supply Chain Management system (SCM), etc, facilitate/ inhibit the ways in which your organisation senses and responds to changes from the business environment.

The questionnaire **should not take more than 20 minutes** of your time to complete.

Section 1: Organisational agility

The following questions are intended to examine **your organisation's agility performance**. Please indicate the **importance** of the indicators to your organisation on the left and **how well your organisation performs** the indicators on the right by selecting the appropriate number in the scale of 1 to 5.

Importance						***Performance***				
Very Unimpotant				**Very Impotant**		**Extremely poor**				
1	2	3	4	5	Constantly look for opportunities to add value to our customers	1	2	3	4	5
1	2	3	4	5	Quickly respond to customers' needs	1	2	3	4	5
1	2	3	4	5	Continuously anticipate our customers' needs	1	2	3	4	5
1	2	3	4	5	Quickly adapt to changes from the market (i.e. regulation changes, technological innovations, cultural shifts, competitors' actions, etc)	1	2	3	4	5
1	2	3	4	5	Quickly shorten the time–to-market of new products and/or services	1	2	3	4	5
1	2	3	4	5	Easily redesign existing business processes	1	2	3	4	5
1	2	3	4	5	Easily create new business processes	1	2	3	4	5
1	2	3	4	5	Easily launch new products/services	1	2	3	4	5
1	2	3	4	5	Easily switch between suppliers	1	2	3	4	5
1	2	3	4	5	Easily establish new supply chain partnerships	1	2	3	4	5
1	2	3	4	5	Easily change the type of resources that we acquire from our	1	2	3	4	5

					suppliers					

Section 2: Enterprise System-enabled Sensing Capability

The following questions are intended to **measure the use of enterprise systems** (ERP, CRM, SCM, etc) in **sensing changes from business environment in your organisation**. Please indicate the extent to which **your organisation's enterprise systems either significantly facilitate or inhibit** your organisation's ability to **quickly** and **effectively** perform the following activities by selecting the appropriate number in the scale of 1 to 5.

					Significantly Facilitate
Capture business information from various sources (customer, competitor, supplier) to identify new business opportunities	1	2	3	4	5
Generate knowledge about the market (market trend, competitors' actions, regulation changes, cultural shifts, technology developments, etc)	1	2	3	4	5
Interpret business intelligence for different management levels (i.e. strategic level, operational level)	1	2	3	4	5
Notify the important changes in the business environment by analysing key performance indicators (KPIs)	1	2	3	4	5
Provide business intelligence to decision makers of different functional units across the organisation	1	2	3	4	5
Develop real time visibility of demand in your supply chain	1	2	3	4	5
Examine trends in the data for the industry foresight	1	2	3	4	5

Section 3: Enterprise System-enabled Responding Capability

The following questions evaluate the use of enterprise systems (ERP, CRM, SCM, etc) in responding to changes from the business environment. Please indicate the extent to which your **enterprise systems either significantly facilitate or inhibit** your organisation's ability to **quickly** and **effectively** perform the following activities by selecting the appropriate number in the scale of 1 to 5.

					Significantly Facilitate
Bring new products/services to market faster than other competitors	1	2	3	4	5
Adjust the production volume of products/services	1	2	3	4	5
Create a high degree of process interconnectivity with trading partners	1	2	3	4	5
Collaboratively design plans with trading partners	1	2	3	4	5
Increase the accuracy of the data used by trading partners in making their planning decision	1	2	3	4	5
Simultaneously develop information systems with several supply chain partners	1	2	3	4	5
Increase the accuracy of information used by top management in making strategic decisions	1	2	3	4	5
Create a high degree of intra-organisational business process interconnectivity	1	2	3	4	5
Generate new business strategies	1	2	3	4	5
Empower end-users for taking actions in business operation	1	2	3	4	5

Section 4: Enterprise System Competence

The following questions evaluate the **quality of the enterprise system in your organisation**. Please select the choice that best indicates your level of agreement or disagreement with each of the following statements on the scale of 1 to 5.

Our enterprise systems:	**Strongly disagree**				**Strongly Agree**
Allow easy transformation of data among various databases	1	2	3	4	5
Are fully integrated with our legacy and in-house developed systems	1	2	3	4	5
Can easily be integrated with add-ons built by third parties	1	2	3	4	5
Are fully integrated with each other (for example CRM with SCM)	1	2	3	4	5
Allows easy integration with our business partners’ systems	1	2	3	4	5
Allow easy sharing of information with our business partners’ systems	1	2	3	4	5
Are fully component based	1	2	3	4	5

Are highly adaptable to future requirements	1	2	3	4	5

	Strongly disagree				**Strongly Agree**
Our end users (business managers, business staff) are sufficiently skilled to effectively use enterprise systems	1	2	3	4	5
Our IT staff are sufficiently skilled to manage enterprise systems	1	2	3	4	5
Our enterprise systems vendor(s) staff have the technical know how to troubleshoot problems quickly	1	2	3	4	5
Our IT staff have the technical skills to integrate enterprise systems with legacy systems	1	2	3	4	5
Our IT staff have the technical know how to develop enterprise systems built-on applications	1	2	3	4	5
Our IT staff understand the business processes supported by the enterprise system(s)	1	2	3	4	5
Our IT staff can effectively transfer enterprise systems knowledge to end users	1	2	3	4	5
Our enterprise systems vendor(s) provide continuous support to our organisation (e.g. extended technical assistance, emergency maintenance update, and special user training)	1	2	3	4	5
Organisational resources (financial, leadership, etc) can be easily mobilised when there is a need to change enterprise systems	1	2	3	4	5
Our IT staff can work cooperatively in cross-functional teams with personnel from other departments	1	2	3	4	5
Our enterprise systems development strategies are aligned with our overall business strategy	1	2	3	4	5
We frequently evaluate the performance of enterprise systems	1	2	3	4	5
We have the knowledge and management skills to use enterprise system in synchronisation with business requirement	1	2	3	4	5

Please indicate to what extent your enterprise systems are used for the following business functions on the scale from 1 to 5.

a. ERP

	Least Extent				**Full Extent**	**Not Available**
Financials (*Financial Accounting, Management Accounting, Financial Supply Chain Management*)	1	2	3	4	5	
Human Capital Management(HCM) (*Employee Life-cycle*	1	2	3	4	5	

management, employee transaction management, HCM Delivery, Workforce Deployment)						
Operations (*Procurement, Inventory & Warehouse Management, Manufacturing, Transportation, Sales Order Management, Customer Service*)	1	2	3	4	5	
Support (*Lifecycle Data management, Program & Project Management, Quality Management, Enterprise Asset Management*)	1	2	3	4	5	
Corporate Services (*Travel Management, Environment Health & Safety, Incentive & Commission Management, Real Estate Management*)	1	2	3	4	5	

b. CRM

	Least Extent				**Full Extent**	**Not Available**
Marketing *(customer targeting, pricing, marketing campaign management)*	1	2	3	4	5	
Sales *(account management, sales lead management, customized sales recommendations for cross-selling and up-selling)*	1	2	3	4	5	
Service *(customer service operation, customer data management, call centre operations, service knowledge database maintenance)*	1	2	3	4	5	
Analytical CRM *(customer value analysis, customer retention rate analysis, sales forecasting)*	1	2	3	4	5	

c. SCM

	Least Extent				**Full Extent**	**Not Available**
Value Chain Planning *(demand planning, collaborative planning, Inventory optimization, Production scheduling)*	1	2	3	4	5	
Execution *(Order fulfilment, Procurement Management, Transportation Management, Warehouse Management, Manufacturing)*	1	2	3	4	5	
Collaboration *(Supplier Network collaboration, Customer Network Collaboration)*	1	2	3	4	5	
Visibility design and Analytics *(Forecasting and replenishment)*	1	2	3	4	5	

Section 5: Environmental Dynamism

The following questions evaluate the characteristic of the business environment within which your company operates. Please evaluate the extent of dynamism of your business environment by selecting the appropriate number on the scale of 1 to 5.

	Very Low				**Very High**
The rate of new product innovation in the industry	1	2	3	4	5
The speed of technology changes related to our organisation's products and/or services	1	2	3	4	5
The rate of change of customers' preferences	1	2	3	4	5
The rate of change of industry regulations	1	2	3	4	5

Section 6: Personal Background & Characteristics of Company

1. Business Unit Name: ____

2. Position/Job Title:

- ○ CIO
- ○ CEO
- ○ Others (Please specify) __________

3. Number of years working in this position? ____years

4. Number of years working for this company? ____years

5. What is the core-business of your organisation?

- ○ Banking/Finance
- ○ Telecom
- ○ Retail
- ○ Manufacturing
- ○ Others, namely: ____________
- ○ Trading
- ○ Information Technology
- ○ Services
- ○ Logistics

6. The number of your organisation's full-time employees:

- ○ Less than 200
- ○ 201 ~ 500

○ 501 ~ 1000

○ 1001 ~ 5000

○ Over 5000

7. The annual revenue of your organisation (in million AUD$):

○ Less than 20

○ 21 ~ 50

○ 51 ~ 100

○ 101~250

○ 251~500

○ 501~1000

○ Over 1000

8. Please indicate the scope and geographical extent of your enterprise system implementation by marking the relevant cell.

Type	**Years in use**	**Scope of the implementation**			**Geographical extent of the implementation**			
		Division	Entire company	Multiple companies	Single site	Multiple sites	National	World wide
ERP	____	€	€	€	€	€	€	€
CRM	____	€	€	€	€	€	€	€
SCM	____	€	€	€	€	€	€	€

If you would like to receive a summary of the results of the study, please provide us with your contact e-mail address. E-mails collected this way will only be used for disseminating the results after which they will be deleted.

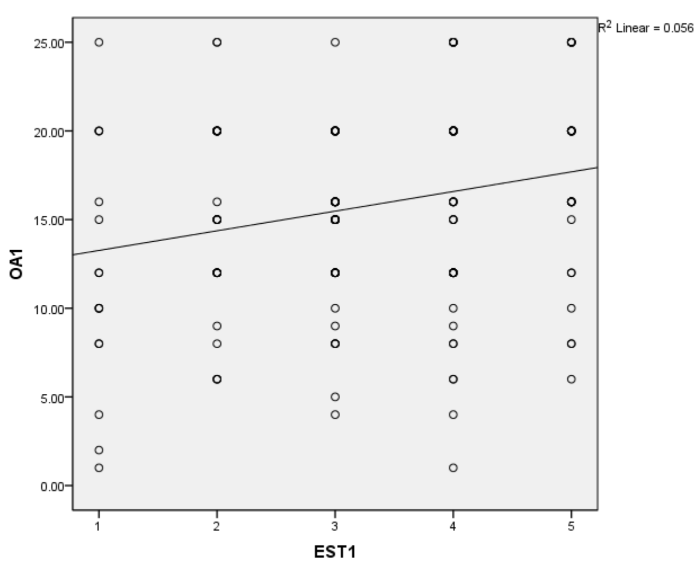
Appendix 5.1. Randomness Of Missing Data Analysis

Separate Variance t-Tests								
Missing data on	Test	Variables						
		OAI	OAP	OA	ESS	ESR	EST	ESHM
YEAR_REV	t	-2.7	-2.1	-2.3	-2.3	-2.5	-2.3	-2.2
	df	10.9	9.8	9.6	10	10	11	10.1
	P(2-tail)	**0.021**	**0.06**	**0.05**	**0.05**	**0.03**	**0.04**	**0.05**
	# Present	169	169	169	169	169	169	169
	# Missing	10	10	10	10	10	10	10
	Mean(Present)	3.79	3.1	12.17	3.3	3.3	3	3.65
	Mean(Missing)	4.2	3.62	15.57	3.84	3.78	3.54	4
ERP_YEAR	t	-0.9	-1.6	-1.2	-0.9	-0.6	-1	-0.7
	df	13.2	14	12.8	13	12	12	12
	P(2-tail)	**0.376**	**0.14**	**0.24**	**0.39**	**0.59**	**0.36**	**0.47**
	# Present	167	167	167	167	167	167	167
	# Missing	12	12	12	12	12	12	12
	Mean(Present)	3.80	3.13	12.29	3.27	3.27	3.04	3.66
	Mean(Missing)	3.95	3.38	13.57	3.46	3.40	3.31	3.82
CRM_YEAR	t	-1.4	-1.3	-1.4	-1.3	-0.6	-1.3	-1
	df	16.4	17	16	16	15	15	14.6
	P(2-tail)	**0.171**	**0.20**	**0.18**	**0.20**	**0.54**	**0.22**	**0.33**
	# Present	165	165	165	165	165	165	165
	# Missing	14	14	14	14	14	14	14
	Mean(Present)	3.79	3.14	12.28	3.2	3.27	3.03	3.66

		5			6			
	Mean(Missing)	4	3.32	13.53	3.53	3.40	3.38	3.85
SCM_YEAR	t	-1.3	-1.5	-1.5	-1.5	-0.9	-1.2	-1.1
	df	14.7	15	14.4	15	13	14	13.2
	P(2-tail)	**0.217**	**0.15**	**0.17**	**0.15**	**0.40**	**0.25**	**0.27**
	# Present	166	166	166	166	166	166	166
	# Missing	13	13	13	13	13	13	13
	Mean(Present)	3.797	3.13	12.28	3.26	3.26	3.03	3.65
	Mean(Missing)	3.993	3.36	13.65	3.58	3.45	3.38	3.89

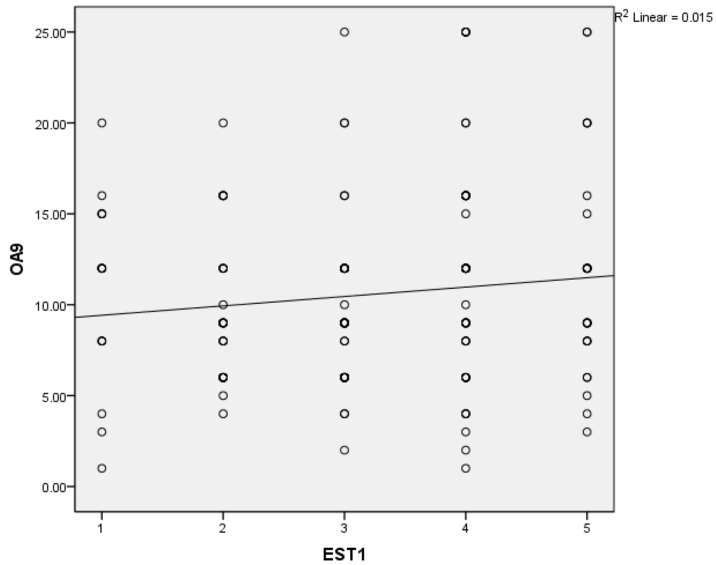
Appendix 5.2. Testing Result Of The Assumption For Homoscedasticity

EST1 (independent variable) and OA1 (dependent variable). R² linear = 0.056. Variables are not homoscedastic .



[redacted]

EST1 (independent variable) and OA9 (dependent variable). R^2 =0.015. Variables are not homoscedastic.



[redacted]

Appendix 5.3. Testing Result Of The Assumption Of Linearity

Test of linearity between independent variable EST1 and dependent variables OA1-OA11.

ANOVA Table						
		Sum of Squares	df	Mean Square	F	Sig.
OA1 * EST1	(Combined)	387.001	4	96.8	3.25	0.01
	Linearity	313.003	1	313.0	10.51	0.00
	Deviation from Linearity	73.998	3	24.7	0.83	**0.48**
OA2 * EST1	(Combined)	720.745	4	180.2	6.60	0.00
	Linearity	640.825	1	640.8	23.46	0.00
	Deviation from Linearity	79.92	3	26.6	0.98	**0.41**
OA3 * EST1	(Combined)	406.981	4	101.7	3.47	0.01
	Linearity	300.235	1	300.2	10.24	0.00
	Deviation from Linearity	106.746	3	35.6	1.21	**0.31**
OA4 * EST1	(Combined)	475.899	4	119.0	3.91	0.01
	Linearity	461.892	1	461.9	15.17	0.00
	Deviation from Linearity	14.007	3	4.7	0.15	**0.93**
OA5 * EST1	(Combined)	344.384	4	86.1	3.46	0.01
	Linearity	241.673	1	241.7	9.70	0.00
	Deviation from Linearity	102.711	3	34.2	1.38	**0.25**
OA6 * EST1	(Combined)	553.299	4	138.3	5.80	0.00
	Linearity	537.443	1	537.4	22.54	0.00
	Deviation from Linearity	15.855	3	5.3	0.22	**0.88**
OA7 * EST1	(Combined)	457.385	4	114.3	4.77	0.00
	Linearity	442.84	1	442.8	18.48	0.00
	Deviation from Linearity	14.545	3	4.8	0.20	**0.90**

OA8 * EST1	(Combined)	438.118	4	109.5	3.58	0.01
	Linearity	313.003	1	313.0	10.23	0.00
	Deviation from Linearity	125.115	3	41.7	1.36	**0.26**
OA9 * EST1	(Combined)	145.872	4	36.5	1.44	0.22
	Linearity	67.971	1	68.0	2.68	0.10
	Deviation from Linearity	77.901	3	26.0	1.02	**0.38**
OA10 * EST1	(Combined)	204.859	4	51.2	1.98	0.10
	Linearity	171.718	1	171.7	6.64	0.01
	Deviation from Linearity	33.141	3	11.0	0.43	**0.73**
OA11 * EST1	(Combined)	139.394	4	34.8	1.45	0.22
	Linearity	87.518	1	87.5	3.64	0.06
	Deviation from Linearity	51.877	3	17.3	0.72	**0.54**

Appendix 5.4. Correlation Matrix Of The Variables

	ESS1	ESS2	ESS3	ESS4	ESS5	ESS6	ESS7	ESR1	ESR2	ESR3	ESR4	ESR5	ESR6	ESR7	ESR8	ESR9	ESR10	EST1	EST2
ESS1	1.00																		
ESS2	0.64	1.00																	
ESS3	0.61	0.63	1.00																
ESS4	0.57	0.55	0.64	1.00															
ESS5	0.58	0.50	0.77	0.65	1.00														
ESS6	0.50	0.49	0.52	0.55	0.52	1.00													
ESS7	0.45	0.48	0.61	0.65	0.59	0.56	1.00												
ESR1	0.53	0.47	0.37	0.42	0.37	0.35	0.35	1.00											
ESR2	0.39	0.27	0.28	0.37	0.31	0.35	0.36	0.44	1.00										
ESR3	0.30	0.24	0.27	0.34	0.31	0.47	0.35	0.40	0.52	1.00									
ESR4	0.36	0.44	0.41	0.47	0.37	0.44	0.51	0.43	0.39	0.62	1.00								
ESR5	0.40	0.42	0.40	0.46	0.43	0.39	0.50	0.46	0.46	0.41	0.64	1.00							
ESR6	0.35	0.28	0.26	0.27	0.31	0.41	0.30	0.38	0.41	0.61	0.65	0.52	1.00						
ESR7	0.48	0.48	0.64	0.53	0.64	0.44	0.53	0.40	0.44	0.38	0.42	0.49	0.30	1.00					
ESR8	0.51	0.43	0.53	0.47	0.55	0.52	0.45	0.40	0.43	0.52	0.53	0.47	0.50	0.56	1.00				
ESR9	0.39	0.44	0.48	0.52	0.41	0.41	0.51	0.37	0.25	0.21	0.48	0.41	0.33	0.52	0.52	1.00			
ESR10	0.43	0.36	0.53	0.41	0.53	0.44	0.48	0.35	0.38	0.40	0.41	0.44	0.37	0.54	0.66	0.53	1.00		
EST1	0.46	0.41	0.45	0.50	0.41	0.45	0.40	0.41	0.32	0.43	0.40	0.36	0.34	0.39	0.49	0.37	0.40	1.00	
EST2	0.45	0.44	0.49	0.47	0.49	0.49	0.49	0.38	0.32	0.43	0.48	0.42	0.31	0.46	0.53	0.44	0.45	0.64	1.00

Appendix 5.5 Independent T-Sample For Geographical Bias In The Sample Location

	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ESS1	.366	.546	-1.417	.158	-.344	.243
ESS2	.838	.361	-.476	.634	-.108	.227
ESS3	1.956	.164	-1.004	.317	-.262	.261
ESS4	1.925	.167	-1.133	.259	-.265	.234
ESS5	2.437	.120	-1.224	.223	-.300	.245
ESS6	.008	.928	-1.057	.292	-.264	.250
ESS7	.038	.847	-.846	.399	-.203	.240
ESR1	.039	.844	-.971	.333	-.191	.197
ESR2	1.601	.207	-.183	.855	-.036	.200
ESR3	.434	.511	-1.066	.288	-.258	.242
ESR4	.819	.367	-.741	.460	-.155	.210
ESR5	.184	.668	-1.065	.288	-.232	.218
ESR6	.276	.600	-.855	.394	-.200	.234
ESR7	3.972	.048	-.849	.397	-.183	.215
ESR8	3.243	.073	-1.178	.240	-.281	.238
ESR9	.581	.447	-.432	.666	-.089	.206
ESR10	.707	.402	-.345	.730	-.077	.224
EST1	2.838	.094	-1.146	.253	-.318	.278
EST2	13.027	.000	-1.927	.056	-.521	.270
EST3	.826	.365	.645	.520	.165	.255
EST4	6.944	.009	-1.313	.191	-.381	.290
EST5	.589	.444	-1.275	.204	-.326	.256
EST6	6.494	.012	-2.167	.032	-.542	.250
EST7	4.926	.028	.366	.715	.102	.279
EST8	.246	.620	.158	.874	.041	.259
ESHM1	.953	.330	-.619	.537	-.153	.247
ESHM2	.447	.505	-.722	.471	-.134	.185
ESHM3	4.071	.045	-.335	.738	-.069	.206

ESHM4	.527	.469	-1.912	.058	-.403	.211
ESHM5	.042	.838	.614	.540	.157	.255
ESHM6	.104	.748	-.429	.669	-.092	.214
ESHM7	.266	.607	-.566	.572	-.116	.205
ESHM8	.001	.978	-.377	.707	-.097	.257
ESHM9	.218	.641	-1.097	.274	-.280	.255
ESHM10	1.171	.281	-.719	.473	-.124	.173
ESHM11	.694	.406	-1.865	.064	-.427	.229
ESHM12	.465	.496	-.856	.393	-.215	.251
ESHM13	.349	.555	-.678	.498	-.152	.224
ED1	.413	.521	.978	.329	.270	.276
ED2	.596	.441	-.949	.344	-.238	.251
ED3	.413	.521	.158	.874	.038	.238
ED4	2.891	.091	.610	.542	.146	.239
OA1	.123	.726	-.382	.703	-.49759	1.30227
OA2	.099	.753	.341	.733	.44063	1.29113
OA3	.721	.397	-.150	.881	-.19439	1.29586
OA4	.800	.372	-1.143	.255	-1.51115	1.32191
OA5	5.505	.020	-.919	.359	-1.09464	1.19128
OA6	.038	.845	-1.177	.241	-1.40325	1.19242
OA7	.190	.664	.008	.993	.00995	1.18752
OA8	1.632	.203	-.702	.484	-.92917	1.32347
OA9	4.276	.040	.351	.726	.41380	1.17939
OA10	3.685	.057	.126	.900	.15099	1.19728
OA11	1.666	.199	.199	.842	.22875	1.14811
Extent of Use	.004	.951	-1.254	.212	-.21560	.17195
Extent of use	3.420	.066	-.930	.354	-.16773	.18040
meanOA	.085	.770	-.481	.631	-.39873	.82923
meanESS	.408	.524	-1.290	.199	-.24933	.19326
meanESR	.771	.381	-1.094	.275	-.17034	.15569

meanEST	3.539	.062	-1.075	.284	-.22261	.20717
meanESHM	1.542	.216	-1.196	.233	-.16187	.13532
meanED	1.734	.190	.269	.788	.05395	.20025
meanESF	1.626	.204	-1.150	.252	-.19166	.16674

Appendix 5.6. Independent Sample T-Test For Non-Response Bias

	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ESS1	.683	.410	-1.077	.283	-.178	.165
ESS2	.753	.387	-.936	.350	-.144	.154
ESS3	.121	.728	-1.493	.137	-.263	.176
ESS4	2.715	.101	-1.178	.240	-.187	.159
ESS5	.667	.415	-.795	.428	-.133	.167
ESS6	.338	.562	-.868	.387	-.147	.170
ESS7	.611	.436	-1.020	.309	-.166	.163
ESR1	1.565	.213	-1.068	.287	-.143	.134
ESR2	.864	.354	.369	.712	.050	.135
ESR3	.728	.395	-.462	.644	-.076	.165
ESR4	2.760	.098	.603	.547	.086	.142
ESR5	.447	.504	-.777	.438	-.115	.148
ESR6	.286	.593	.791	.430	.125	.159
ESR7	.636	.426	-.600	.549	-.088	.146
ESR8	1.615	.205	-.086	.932	-.014	.162
ESR9	.977	.324	1.281	.202	.179	.139
ESR10	.073	.787	.183	.855	.028	.152
EST1	.052	.821	-1.820	.070	-.341	.187
EST2	.028	.867	-.676	.500	-.125	.185
EST3	.244	.622	-1.421	.157	-.245	.173
EST4	.231	.632	-2.892	**.004**	-.560	.194
EST5	1.196	.276	-.192	.848	-.033	.174

EST6	1.087	.299	-1.801	.073	-.307	.170
EST7	.139	.710	-.666	.506	-.126	.189
EST8	.235	.629	-1.152	.251	-.202	.175
ESHM1	5.288	.023	.297	.767	.050	.168
ESHM2	.042	.839	-.044	.965	-.006	.126
ESHM3	.417	.519	-1.368	.173	-.191	.139
ESHM4	1.276	.260	.027	.979	.004	.144
ESHM5	.018	.894	.074	.941	.013	.174
ESHM6	11.927	.001	1.176	.241	.170	.145
ESHM7	1.519	.219	.461	.645	.064	.139
ESHM8	.008	.929	-.520	.604	-.091	.174
ESHM9	.112	.739	-1.175	.241	-.203	.173
ESHM10	.087	.768	1.312	.191	.153	.117
ESHM11	1.511	.221	.392	.695	.062	.157
ESHM12	.098	.755	.091	.928	.016	.171
ESHM13	.178	.673	.458	.647	.070	.152
ED1	1.214	.272	-2.450	**.015**	-.453	.185
ED2	.214	.644	-.279	.781	-.048	.171
ED3	.004	.948	-1.211	.228	-.195	.161
ED4	1.223	.270	-.774	.440	-.125	.162
OA1	2.159	.144	1.279	.203	1.12573	.88047
OA2	.214	.644	.250	.803	.21881	.87673
OA3	1.447	.231	2.069	**.040**	1.79856	.86942
OA4	1.165	.282	-.513	.608	-.46221	.90013
OA5	2.129	.146	.361	.719	.29216	.81044
OA6	3.992	.047	.319	.750	.25896	.81251
OA7	.083	.774	-.736	.463	-.59239	.80503
OA8	4.062	.045	-.629	.530	-.56530	.89880
OA9	.821	.366	-.367	.714	-.29355	.80071
OA10	.265	.608	-.999	.319	-.80967	.81064
OA11	.637	.426	.227	.821	.17685	.77947
meanOA	3.177	.076	.185	.853	.10436	.56331

meanESS	3.392	.067	-1.326	.186	-.17400	.13118
meanESR	.359	.550	.030	.976	.00321	.10606
meanEST	.087	.769	-1.733	.085	-.24251	.13993
meanESHM	.106	.745	.092	.927	.00851	.09224
meanED	.124	.725	-1.518	.131	-.20516	.13511
meanESF	.997	.319	1.421	.157	.16057	.11298

Appendix 5.7. Total Variance Explained for Common Method Bias Test

Total Variance Explained							
Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
dimension0	1	16.341	29.711	29.711	16.341	29.711	29.711
	2	4.04	7.345	37.056			
	3	2.952	5.367	42.423			
	4	2.341	4.256	46.679			
	5	1.988	3.615	50.295			
	6	1.83	3.327	53.622			
	7	1.673	3.042	56.664			
	8	1.557	2.831	59.494			
	9	1.342	2.44	61.934			
	10	1.239	2.253	64.187			
	11	1.18	2.146	66.333			
	12	1.023	1.86	68.193			
	13	0.996	1.811	70.004			
	14	0.988	1.797	71.801			
	15	0.945	1.718	73.518			
	16	0.829	1.508	75.026			
	17	0.765	1.391	76.417			

	18	0.749	1.362	77.779			
	19	0.694	1.262	79.041			
	20	0.668	1.214	80.255			
	21	0.647	1.177	81.432			
	22	0.597	1.085	82.516			
	23	0.556	1.011	83.528			
	24	0.543	0.987	84.515			
	25	0.511	0.93	85.445			
	26	0.489	0.889	86.333			
	27	0.466	0.847	87.18			
	28	0.448	0.815	87.995			
	29	0.441	0.802	88.798			
	30	0.398	0.724	89.522			
	31	0.393	0.715	90.237			
	32	0.377	0.686	90.924			
	33	0.373	0.678	91.601			
	34	0.349	0.635	92.236			
	35	0.341	0.62	92.856			
	36	0.323	0.587	93.443			
	37	0.308	0.561	94.004			
	38	0.295	0.537	94.54			
	39	0.285	0.519	95.06			
	40	0.259	0.472	95.531			

	41	0.245	0.446	95.977			
	42	0.243	0.442	96.419			
	43	0.224	0.408	96.827			
	44	0.215	0.391	97.218			
	45	0.195	0.354	97.572			
	46	0.188	0.341	97.913			
	47	0.179	0.325	98.238			
	48	0.164	0.299	98.537			
	49	0.146	0.266	98.803			
	50	0.136	0.248	99.05			
	51	0.124	0.226	99.277			
	52	0.11	0.201	99.477			
	53	0.104	0.189	99.667			
	54	0.097	0.177	99.843			
	55	0.086	0.157	100			
Extraction Method: Principal Component Analysis.							

Appendix 6.1 The Item-Total Correlation Matrix

Var.	Item	Item-Total Correlation	SMC	Alpha if Item Deleted	Alpha	Var.	Item	Item-Total Correlation	SMC	Alpha if Item Deleted	Alpha
OA	OA1	.518	.487	.870	8.760	**EST**	EST1	.714	.563	.890	.904
	OA2	.596	.459	.864			EST2	.648	.487	.896	
	OA3	.635	.541	.861			EST3	.708	.540	.891	
	OA4	.529	.398	.869			EST4	.691	.514	.892	
	OA5	.641	.519	.861			EST5	.733	.671	.888	
	OA6	.673	.697	.859			EST6	.709	.646	.890	
	OA7	.644	.708	.861			EST7	.657	.496	.895	
	OA8	.628	.470	.862			EST8	.706	.546	.891	
	OA9	.485	.481	.871		**ESHM**	ESHM1	.446	.306	.846	.852
	OA10	.522	.510	.869			ESHM2	.531	.400	.841	
	OA11	.541	.467	.868			ESHM3	.343	.440	.852	
ESS	ESS1	.689	.524	.893	.904		ESHM4	.594	.566	.837	
	ESS2	.682	.529	.894			ESHM5	.488	.529	.844	
	ESS3	.792	.691	.881			ESHM6	.590	.515	.837	
	ESS4	.754	.583	.886			ESHM7	.550	.430	.840	
	ESS5	.758	.655	.885			ESHM8	.430	.398	.848	
	ESS6	.641	.428	.898			ESHM9	.499	.307	.843	
	ESS7	.693	.527	.892			ESHM10	.514	.322	.843	

	ESR1	.557	.334	.886			ESHM11	.468	.491	.845	
	ESR2	.572	.406	.885			ESHM12	.551	.499	.839	
	ESR3	.633	.576	.882			ESHM13	.694	.636	.830	
	ESR4	.722	.649	.875		**ESF**	ES_FS	.454	.206	.a	**.624**
ESR	ESR5	.667	.533	.879	.892		EoU	.454	.206	.a	
	ESR6	.634	.529	.881		**ED**	ED1	.597	.422	.773	
	ESR7	.626	.481	.882			ED2	.699	.516	.719	.806
	ESR8	.723	.586	.875			ED3	.702	.506	.721	
	ESR9	.552	.471	.887			ED4	.506	.317	.809	
	ESR10	.635	.519	.881							

The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Appendix 6.2. Factor Structure After Exploratory Factor Analysis

Constructs	Items	Factors										
		1	2	3	4	5	6	7	8	9	10	11
Organisational Agility	OA7	0.85										
	OA6	0.78										
	OA4	0.67										
	OA5	0.61										
	OA8	0.6										
	OA1		0.87									
	OA3		0.79									
	OA2		0.7									
	OA9			0.84								
	OA10			0.82								
	OA11			0.79								
ES-enabled sensing capability	ESS3				0.87							
	ESS5				0.82							
	ESS4				0.78							
	ESS2				0.73							
	ESS1				0.71							
	ESS7				0.71							
	ESR7				0.7							
	ESR9				0.61							
	ESS6				0.59							
	ESR10				0.57							
ES	ESR6					0.83						

enabled responding capability	ESR3					0.82						
	ESR4					0.77						
	ESR5					0.63						
	ESR2					0.63						
	ESR1					0.5						
ES competence	EST5						0.79					
	EST3						0.78					
	EST8						0.76					
	EST6						0.75					
	EST1						0.73					
	EST4						0.71					
	EST7						0.7					
	EST2						0.66					
	ESHM4							0.79				
	ESHM5							0.78				
	ESHM6							0.74				
	ESHM2							0.67				
	ESHM7							0.6				
	ESHM11								0.81			
	ESHM13								0.77			
	ESHM12								0.76			
	ESHM3									0.86		
	ESHM8									0.7		

	ESHM1									0.57		
	ES_FS										0.91	
	EoU										0.72	
Environmental dynamism	ED3											0.85
	ED2											0.85
	ED1											0.78
	ED4											0.7

Appendix 6.3. The T-Values Outer Loading First Order Constructs

	Sample Mean (M)	Standard Deviation	Standard Error	T -value
ES_FS <- ESF	0.556	0.148	0.148	3.952
ESR9 <- ESS	0.677	0.055	0.055	12.381
ESR10 <- ESS	0.687	0.053	0.053	13.047
ESR1 <- ESR	0.688	0.053	0.053	13.131
ESR2 <- ESR	0.683	0.053	0.053	13.142
ESHM2 <- ESH	0.713	0.050	0.050	14.175
OA4 <- OA_O	0.710	0.047	0.047	15.189
EST2 <- EST	0.735	0.045	0.045	16.416
ESR3 <- ESR	0.761	0.045	0.045	16.936
ESHM11 <- ESM	0.813	0.045	0.045	18.086
ESHM5 <- ESH	0.774	0.042	0.042	18.341
ESR6 <- ESR	0.773	0.042	0.042	18.675
ESHM3 <- ESV	0.840	0.045	0.045	18.853
EST7 <- EST	0.736	0.039	0.039	19.133
EST4 <- EST	0.769	0.039	0.039	19.634
ESS2 <- ESS	0.736	0.037	0.037	19.817
ESR7 <- ESS	0.756	0.038	0.038	19.900
ESS1 <- ESS	0.751	0.038	0.038	19.966

OA8 <- OA_O	0.764	0.038	0.038	20.254
EST8 <- EST	0.776	0.038	0.038	20.636
ESS6 <- ESS	0.722	0.034	0.034	20.999
ESR5 <- ESR	0.778	0.036	0.036	21.656
EST6 <- EST	0.788	0.035	0.035	22.593
OA5 <- OA_O	0.776	0.033	0.033	23.675
EST3 <- EST	0.779	0.033	0.033	23.758
ESS7 <- ESS	0.774	0.033	0.033	23.795
EST1 <- EST	0.789	0.032	0.032	24.367
ESHM6 <- ESH	0.806	0.031	0.031	25.703
ESHM4 <- ESH	0.810	0.031	0.031	26.297
OA11 <- OA_P	0.851	0.031	0.031	27.277
OA9 <- OA_P	0.846	0.031	0.031	27.329
OA1 <- OA_C	0.839	0.029	0.029	29.311
EST5 <- EST	0.809	0.027	0.027	29.573
OA10 <- OA_P	0.862	0.029	0.029	29.892
ESS4 <- ESS	0.800	0.026	0.026	30.554
ESS5 <- ESS	0.813	0.026	0.026	31.016
OA6 <- OA_O	0.819	0.026	0.026	31.867
OA2 <- OA_C	0.840	0.025	0.025	34.198
ESHM12 <- ESM	0.848	0.024	0.024	34.850

OA7 <- OA_O	0.829	0.024	0.024	35.164
ESR4 <- ESR	0.835	0.023	0.023	35.904
ESS3 <- ESS	0.840	0.023	0.023	36.898
ESHM8 <- ESV	0.906	0.023	0.023	38.710
OA3 <- OA_C	0.869	0.019	0.019	46.234
EOU <- ESF	0.982	0.017	0.017	58.523
ESHM13 <- ESM	0.905	0.011	0.011	82.854

Appendix 6.4. Loading And Cross-Loading For The Measurement Model

	ESF	ESH	ESM	ESR	ESS	EST	ESV	OA_C	OA_O	OA_P
EOU	**0.988**	0.332	0.405	0.433	0.512	0.436	0.230	0.437	0.412	0.273
ES_FS	**0.586**	0.057	0.011	0.085	0.119	0.027	0.044	0.021	-0.010	0.042
ESHM4	0.237	**0.811**	0.382	0.269	0.235	0.399	0.243	0.316	0.354	0.027
ESHM6	0.226	**0.808**	0.457	0.306	0.247	0.306	0.187	0.212	0.302	0.134
ESHM5	0.273	**0.774**	0.310	0.292	0.267	0.364	0.150	0.301	0.380	0.091
ESHM2	0.211	**0.715**	0.307	0.247	0.258	0.340	0.246	0.184	0.243	0.108
ESHM7	0.245	**0.696**	0.369	0.193	0.168	0.217	0.278	0.163	0.269	0.087
ESHM13	0.323	0.542	**0.905**	0.404	0.440	0.427	0.272	0.463	0.419	0.185
ESHM12	0.372	0.351	**0.849**	0.373	0.367	0.378	0.303	0.419	0.363	0.120
ESHM11	0.254	0.315	**0.814**	0.341	0.411	0.392	0.088	0.360	0.375	0.170
ESR4	0.414	0.383	0.427	**0.836**	0.567	0.552	0.206	0.419	0.423	0.195
ESR5	0.350	0.261	0.361	**0.780**	0.571	0.464	0.159	0.326	0.396	0.151
ESR6	0.342	0.301	0.301	**0.778**	0.422	0.497	0.161	0.288	0.260	0.144
ESR3	0.228	0.238	0.284	**0.766**	0.434	0.512	0.177	0.247	0.260	0.117
ESR1	0.241	0.209	0.314	**0.693**	0.528	0.474	0.152	0.306	0.521	0.277
ESR2	0.256	0.147	0.268	**0.689**	0.452	0.460	0.072	0.327	0.336	0.181
ESS3	0.395	0.215	0.439	0.447	**0.843**	0.496	0.271	0.264	0.334	0.166
ESS5	0.443	0.188	0.325	0.462	**0.815**	0.481	0.195	0.284	0.281	0.125

ESS4	0.324	0.253	0.307	0.518	**0.801**	0.498	0.271	0.281	0.285	0.189
ESS7	0.350	0.238	0.394	0.528	**0.776**	0.463	0.201	0.374	0.383	0.179
ESR7	0.322	0.156	0.303	0.538	**0.760**	0.468	0.204	0.271	0.297	0.119
ESS1	0.435	0.267	0.382	0.515	**0.752**	0.579	0.180	0.381	0.427	0.237
ESS2	0.378	0.241	0.334	0.480	**0.738**	0.443	0.244	0.380	0.385	0.190
ESS6	0.333	0.313	0.323	0.529	**0.722**	0.535	0.286	0.329	0.359	0.182
ESR10	0.374	0.195	0.406	0.518	**0.690**	0.507	0.160	0.312	0.280	0.165
ESR9	0.325	0.251	0.371	0.459	**0.681**	0.450	0.197	0.280	0.264	0.158
EST5	0.344	0.317	0.353	0.574	0.461	**0.810**	0.265	0.295	0.318	0.118
EST1	0.296	0.336	0.394	0.497	0.560	**0.790**	0.284	0.320	0.356	0.179
EST6	0.376	0.332	0.372	0.572	0.534	**0.790**	0.290	0.254	0.280	0.162
EST3	0.171	0.291	0.366	0.461	0.445	**0.782**	0.260	0.238	0.337	0.066
EST8	0.261	0.266	0.329	0.555	0.533	**0.779**	0.311	0.306	0.394	0.195
EST4	0.364	0.396	0.357	0.442	0.449	**0.773**	0.300	0.213	0.312	0.129
EST7	0.301	0.308	0.267	0.408	0.441	**0.737**	0.343	0.236	0.353	0.152
EST2	0.364	0.396	0.442	0.520	0.615	**0.737**	0.166	0.315	0.393	0.178
ESHM8	0.234	0.284	0.283	0.155	0.268	0.325	**0.906**	0.216	0.168	0.194
ESHM3	0.136	0.215	0.174	0.216	0.242	0.300	**0.846**	0.103	0.141	0.093
OA3	0.357	0.258	0.410	0.407	0.391	0.283	0.160	**0.870**	0.556	0.323
OA1	0.329	0.213	0.447	0.280	0.277	0.255	0.178	**0.841**	0.408	0.269
OA2	0.336	0.313	0.391	0.388	0.391	0.354	0.147	**0.840**	0.519	0.319
OA7	0.286	0.369	0.361	0.387	0.378	0.361	0.105	0.381	**0.830**	0.450

OA6	0.393	0.378	0.394	0.415	0.378	0.413	0.094	0.455	**0.820**	0.464
OA5	0.271	0.260	0.367	0.427	0.294	0.309	0.203	0.543	**0.778**	0.318
OA8	0.276	0.296	0.271	0.318	0.349	0.311	0.172	0.462	**0.765**	0.401
OA4	0.222	0.282	0.372	0.375	0.312	0.330	0.122	0.457	**0.712**	0.221
OA11	0.262	0.125	0.218	0.178	0.231	0.170	0.156	0.341	0.429	**0.853**
OA10	0.233	0.154	0.157	0.271	0.170	0.207	0.171	0.296	0.427	**0.863**
OA9	0.155	0.013	0.094	0.156	0.182	0.107	0.105	0.282	0.371	**0.849**

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